AMSAT
Radio Amateur Satellite Corporation
P.O. BOX 27, WASHINGTON, D.C. 20044

December 15, 1980

Mr. H. S. Magnuski
311 Stanford Avenue
Menlo Park, CA 94025

Dear OM:

I'm writing to you as a key supporter and Life Member of AMSAT to review the happenings of 1980, to describe our current activities and needs, to transmit to you my warmest Holiday Greetings, and to give you my New Year's prophesy on the directions of the future. I am also enclosing a questionnaire which, if filled out and returned, will enter you in our Phase III Support Sweepstakes.

On New Year's day, 1980 we were involved in an intensive period of construction, integration and testing that, two months later, would culminate in the completion of Phase-IIIA --- an amateur radio satellite that rivaled the best produced by the professionals. By late February, AMSAT's new spacecraft was ready for shipment to the European Space Agency (ESA) facility in Toulouse, France for launch vehicle integration and acceptance testing. All continued to go well, the hardware was shipped to Marburg for a memory transplant and final tuning of the antennas, and thence shipped to French Guiana for the launch.

All of AMSAT's resources
had been expended
to make Phase-IIIA happen.

And then the unthinkable.
BLACK FRIDAY. May 23, 1980
Ariane launch vehicle fails.
Phase-IIIA is lost.

And the doomsayers said,
"AMSAT IS DEAD!"

The gloom and despair and depression lasted for about a day when an interesting metamorphosis occurred. The "hard-core" of the technical workers, including both Jan King and Karl Meinzer began saying, "Damn it. We worked too hard to quit now. Let's try again. Lightning can't strike twice!" YOU, our supporters and benefactors, said "Don't give up now. We're behind you all the way and pledge our continued support." Jan, who had already accepted a job in Utah, decided to stay on the team as an employee of AMSAT. Karl also refused to walk away from half a decade of hard work on Phase III. Through the months that have followed, we have been consolidating our resources. The enthusiasm and morale are higher than ever. Like Phoenix, we have emerged from the ashes with an organization that is stronger than ever.

----- As we enter 1981, just look at what is happening -----

- We have secured a ride for Phase-IIIB. The launch date is scheduled for February 24, 1982 on Ariane flight L-7. Hardware is already under construction in Marburg, Budapest and Washington.
- We are engaged in negotiations for a Phase-IIIC launch, with a date circa 1983. Thus two sets of Phase-III hardware are being constructed in parallel.
- G3YJO and his colleagues at the University of Surrey are well along on hardware for UoSAT -- the first amateur scientific research satellite -- scheduled for launch in September, 1981.
- A new team in California, drawing on the resources of AMSAT and Project OSCAR has been formed. They will be assisting the AMSAT team in Canada to provide amateur radio's first geostationary capabilities circa 1984.
- A new team, RACE (Radio Amateur Club de l'Espace), has been formed in France with strong ties to ESA and CNES (Centre National des Etudes Spatiales). They are planning Phase-III type launches circa 1984-5.
- The AMSAT teams in Japan, Italy, West Germany, Canada and the US are already at work on new concepts for missions later on in the decade. Expect to see microwave and digital transponders as well as linked satellite communications systems.
- ORBIT magazine continues to grow, although advertising and newsstand circulation revenues are disappointing.
- AMSAT, its affiliated societies, and amateur radio organizations around the world, have begun concerted fund-raising campaigns to help make these programs happen. A number of these involve novel and innovative approaches which have never before been tried. Don't be surprised at what you see in the next few months!!

With all this activity, we do have some problems, and you may be able to help out. Most of the problems have the common theme of scheduling of our most precious resources,

PEOPLE and MONEY.

--- THE PEOPLE SITUATION ---

The hardware for Phase-IIIB will have to be finished and delivered less than one year from today. At the same time, we are supporting the UoSAT fabrication, integration and launch activities. The new fund-raising initiatives show a great deal of promise, but require considerable effort on our part. To keep YOU informed of the activities through ORBIT, the nets, and other publications, and to provide the services that the members desire, and to keep AMSAT's business affairs on an even keel seems a never ending drain on our already limited resources. And yet, the enthusiasm and desire to succeed is seen in every one of the workers that make up the nucleus of AMSAT. This enthusiasm must be contagious, for we see new volunteers showing up daily. And the new blood has already made its mark, both by stepping in to fill the needs of the organization, and by further enhancing the morale.

Do you share the enthusiasm?
Do you have some untapped talent that you can offer?

---- THE MONEY SITUATION ----

THE most serious problem is financial. I gave a snap-shot of the entire situation (as of August), no holds barred, plusses and minuses, in my article "SPACECRAFT ECONOMICS" on page 22 of the Sept/Oct issue of ORBIT. Since that time a few things have changed. The accelerated Phase-IIIB construction schedule, the decision to build Phase-IIIC in parallel, the requirements of the other activities, and the high inflation rate have upped the ante for the first half of 1981. The new fund-raising activities to support hardware construction look very promising over the long haul, but it is taking time to get these campaigns rolling -- time which we don't have if we are to be ready with Phase-IIIB a year from now.

Assuming that these new campaigns pick up momentum by next summer, we will need $70-100,000 to bridge the gap. If each of the Life Members gave just $50, we could make it through this critical period, especially if your contributions are applied against the ARRL Foundation and Hoover matching grants discussed in my article. Of course, some won't heed my plea, so I hope that you will be able to give more -- remember that the total needs for the next two years are $250,000.

When you paid for your Life Membership, we used half of your contribution to support the construction of satellite hardware, and set the other half aside as a reserve. We planned that the interest derived from the reserves would "pay" for the services you receive. We have just reviewed the "membership services" budget, which includes "office" expenses and costs of producing ORBIT. To sustain the present level of services, it comes to $16 per member per year, exclusive of overseas mailings of ORBIT. The members who pay their dues annually contribute just enough to provide for the services they derive. But the interest on YOUR money which we hold in reserve is simply inadequate to pay for the services you receive.

I WILL NOT PERMIT money earmarked for satellite hardware construction to be used to provide "member services". I wish we were in a position where revenues from dues were providing much needed funds to support technical activities.

But with the present size of AMSAT, with costs increasing, and with advertising not paying the costs of producing ORBIT, we do not have this luxury. The best we can do is to require the member service activities to operate within their revenues. I need to hear from you -- should we sustain the services at their present levels or should we cut back significantly? Do we really want ORBIT Magazine to speak for AMSAT's exciting programs? Can we find some way to increase advertising revenues and ORBIT circulation to help offset these costs?

As an AMSAT Life Member, you have expressed your high level of interest in the amateur radio space program. You are known to be among those leading the parade of achievement of which we are so justly proud. It is entirely appropriate, then, that it is to you that I first turn for renewed support and assistance.

Let me redeem the pledges you made
in the days following Black Friday.
Will you again make an investment in Space,
Amateur Radio's most exciting frontier?

I've enclosed a form which I would like to ask you to take the time to fill out. Since I need the answers quickly, I'm giving you an added incentive. We have received a donation of a clean, pristine Collins 75S-3C (round emblem), serial number MCN4376. For the Life Members who return the questionnaire so that we receive it by February 24, 1981 (just one year before the Phase-IIIB launch) we will hold a Phase-III Support Sweepstakes. The winner, chosen by random draw, will have this valuable piece of equipment to grace his/her shack. Although the questionnaire blatantly requests donations, you don't have to contribute to participate in the Sweepstakes.

It is you who will help forge the future of AMSAT. We await your response, your vote of confidence, so that we may continue to expand amateur radio's horizons in space.

73,

Tom

Tom Clark - W3IWI

Hank,
Tnx for the support given AMSAT over the years.
73, Rich K1HTV

P.S. If you are one of the many generous supporters who has already sent in a contribution since Black Friday, I would like to thank you again for your support and confidence. You should already have received a receipt and we will automatically enter you in the Sweepstakes. Of course, we hope that you will be able to help us again now!

904 - 1075 Comox Street
Vancouver, British Columbia
CANADA V6E 1K2
December 14th 1980

Dear Hank;

I was pleased to see your article on packet radio in the November edition of ORBIT. I found it very interesting since I too wrote a similar program also in PASCAL several months ago. We must be thinking on the same wavelength...HI..HI. Unfortunately, I didn't have enough computer time to make the long runs necessary to gain meaningful statistics. I was trying to determine the throughput of a network with carrier sense but without full connectivity between terminals talking to a single station.

Your article gives us some insight to the matter of slow data rates with propagation delays and carrier sense. You had a very valid idea about using the full-duplex features of OSCAR phase III B to determine if there were conflicts with packets. With your method, the only ambiguity and therefore loss of throughput would be due to time lag and equipment sense response time.

There is another way that you may enhance the throughput if the packet length is greater than the propagation in time but with their ratio of significant size. It is very simple to send the frame count as a byte within the header shortly after the the bit-oriented flag. The micro-processors at all the earth stations predict when the end of the packet occur. The bit rate and message length is known and are used in the calculation of a simple multiplication. Also the propagation delay time is known either from a prediction table or from measured results. Therefore, a station waiting to send a packet anticipates by as much as half the propagation delay, due to relative time measure in space and on earth. The effect would be similar to the improved throughput by changing between pure and slotted ALOHA but would not have the disadvantages of poor packet utiliza-

tion with fixed length size. The overhead of another byte should be well offset by improved throughput. The implementation is rather simple and the calculation short enough to be executed between frames on the fly. It is also compatable in a existing network of carrier sense and would only be significant in terms of efficiency.

I did have a question about your program... I couldn't find the place where you put the rescheduled packet into a que. It would seem to me that the offered traffic would continue at the same random rate (unless the user gives up) while the packets that were hit backlog to multiple depths. The throughput may not be as good as anticipated!!!

I should have access to a computer that operates in PASCAL in the near future to be able to run both of the programs without limitations on the run time. I hope that you will continue in your research as this type of information will be very valuable to the project.

Yours Truly,

Robert C. Livingston

VE7CYB

311 Stanford Avenue
Menlo Park, CA 94025
January 6th, 1981

Mr. Robert C. Livingston, VE7CYB
904 - 1075 Comox Street
Vancouver, B.C., CANADA V6E 1K2

Dear Bob:

Thank you very much for your letter of December 14th. I have been following the work of the VADCG and am impressed by the number of good ideas being generated up there. I definitely like the approach, and the packet radio repeater that went into operation here on December 10th uses a very similar form of HDLC protocol. We are also building four VADCG boards here.

Your idea of a byte count for use in predicting end-of-packet is very clever and I had not thought of it. It certainly deserves a test in the simulator.

In answer to your question about the program, the station remains in the "old packet" state until it successfully retransmits. No new traffic will be generated while in this state. There is no queue for rescheduled packets. This implies that traffic generation will decrease as a function of channel loading, a situation which is often typical of interactive users. One could, of course, revise the program to generate traffic at a rate independent of channel conditions.

With the new launch date set for Phase IIIB, work on the AMICON spec should resume shortly. I will add your name to the list for comments on the next draft.

Best regards for 1981,

H. S. Magnuski, KA6M

COPY

December 18, 1979

Mr. Vern Riportella
Box 56
Warwick, NY 10990

Dear Vern:

I enjoyed our recent discussion and want to thank you for taking the time to bring me up to date on activities surrounding the Data Special Service Channel.

Enclosed you will find a short bibliography which I've put together on topics related to personal computer networks.

I wish you and your family a Merry Christmas and a Happy New Year, and I look forward to working with you on AMICON in the coming year.

Yours sincerely,

H.S. Magnuski
President

HSM:rdt

Enc

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Vern "Rip" Riportella
WA2LQQ
AMICON Coordinator
Box 56
Warwick, N.Y., 10990
11 Mar 80

Hank Magnuski, KA6M
311 Stanford Ave.
Menlo Park, Ca., 94025

Dear Hank:

Sorry for the delay in replying to your last telephone call of 29 Feb (I think it was).

I hope that the delay has not dulled your appetite nor your enthusiasm. As you are aware, there are many, many other activities within AMSAT that require attention. Some of them are of a higher precedence than AMICON is at the moment.

Nevertheless, I wish you to do the following. Please read the attached letter which I have just written to an AMSAT colleague down south of you. It contains some points regarding committment that I have remarked to you once or twice. Most of the words and tone will be familiar to you I suspect.

Next, as regards a specific assignment, please begin the following task:

Produce an organized outline of an AMICON System Specification or AMSAT Standard Protocol. The purpose of the outline is to allow identification of those design areas that need to be addressed. A logical approach to this task would be to take a typical CCITT or EIA or ANSI spec for a protocol and for a network and to copy the paragraph headings. Once this is done we will know the areas in which we must consider trades between extant Protocols and homebrew. If we're lucky we may find that one of the popular protocols can be easily adapted for AMICON use with a minimum of heartburn. In any case we won't know till we try. So please get started on the outline. You may proceed with the task as briefed and with the understanding that the refinement of the outline and the development of each identified topic will be an iterative process. Dont get easily discouraged. Till we exchange a bunch of information on the policy and philosophy of AMICON, most of the stuff you generate will be off-target. On the other hand, your ability to employ successive approximation algorithms will be a distinct advantage.

As I mentioned to you some time ago, we are looking for individuals to take responsibility at several levels for AMICON. At the local level, we are looking for persons to indoctrinate and guide computer clubs and interest groups in focusing their interests on AMICON once the AMSAT Standard is firm. On the other hand we are also looking for persons to take a lead role in the definition of the network and the machinations of same.

As far as a title to describe your responsibilities, take your pick. May I suggest Network Design Consultant. That takes in a bunch of evils. HI. If that will do, use it. Also, you may feel free to use your resources to suggest future courses of develop ment for the AMICON. When we talked on the phone last I metioned a thought that perhaps we might consider logging the channel to a "group" for, say, a week and let them do some experimentation to develop basic data on the parameters we'll need to integrate into the systems design process. For example, is 1200 baud just right? What to do about propagation delays? Do we want a 'go back 3 packets and rexmit' type of error recovery or what? Lots and lots of things to think about.

I would appreciate if you would begin to communicate your thoughts and proposed uses for AMICON to me. You will, I expect, represent the interest group that has formed in your area and distill their ideas.

My participation in the detailed desigm process will be reduced as various design tasks are farmed out to responsible individuals such as yourself. I will, however, review the recommendations of the various design groups to insure that the resultant design complies both in spirit and in function with the charter authorized by the AMSAT Board of Directors. Until I understand what areas you wish to(and can) tackle, I must be vague as regards the total extent of your involvement. However, I would encourage you to bite off as much as you believe you can handle and to thereafter massage that chunk into the best jewel you know how.

For example, I have the impression from talking with you that you would consider it unwise to assign you areas of responsibility within the area of hardware or signaling techniques as your background here is skinny. On the other hand, you've indicated that software and in particular comm-drivers and modules are your specialty, (e.g. you mentioned HDLC). What is your best talent, Hank?

As I mentioned to Wally in the attached letter, it would be helpful to have some of your background on paper to allow better appreciation of where you do (and could) fit into the picture. Do you have a resume?

Finally, if I am slow in responding to your letters, please allow that as are many others in the AMSAT group, we are heavily overloaded and find difficulty in making prompt replies at all times. So please adopt the following rule. I manage under the premises of "Management by Exception." In other words, if you don't hear from me, you can assume that all is well.

73 and pls get back to me with the 'stuff'

P.S. I've sent Wally, WA6JPR, the Bibliography you sent me and as you can read, asked him to collect the doss into a Library for reference. You may want to contact Wally to see if you can help each other.

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Vern "Rip" Riportella, WA2LQQ
AMICON Coordinator
Box 56
Warwick, N.Y., 10990
11 Mar 80

Wally Lindstruth, WA6JPR
2413 Burritt Ave
Redondo Beach, Ca., 90378

Dear Wally:

Thanks for your call the other day!

As you may have gathered from your conversation with Skip, W6PAJ and your conversation with me, getting interested in "contributing in positive, meaningful ways" to AMSAT and actually doing it are two separate things.

If you read my article in the AMSAT Newsletter last Autumn, I need not repeat the challenge that faces us. Suffice to say that many of us are very busy trying to balance the demands of our 'Hobby' (Ha!) with the demands of 'normal' interfacing to family and society.

Nevertheless, we do need help and volunteers to help are welcomed (in the best manner possible under the circumstances). What we desperately need now is a group of 'pre-calibrated' individuals to each take a chunk of the problem and come back with a solution 'n' days later. This would ideally be accomplished with no mid-course corrections or consultations with management required (a situation that can never really exist). The question then becomes, how many 'trainees' can one manager train and still fulfill his critical mission-function? Can you take a vague notion of an assignment within an ill-defined concept (such as AMICON) and come back 2 months later with a perfectly acceptable product? Of course not.

So if we need your help (which we do), but we can't spend too much time on indoctrination (which would cause slippage in other parts of the program) how shall we get you on board and producing usable products?

Let's try a word picture.

Imagine, if you will, a bus load of commuters careening through the suburbs attempting to reach the train station before the train departs. Now the bus driver knows the bus very well but doesn't know the route having just been transferred from another route. Gamely the driver asks one of the passengers which is the best way to the station so that they may beat the train's departure. But the other passengers object suggesting that the first passenger doesn't really know what he's talking about since he always slept enroute previously. Now there appears curbside the new passenger. He waves frantically to attract the driver's attention as it appears certain to the potential new passenger that the speeding bus will pass him by. Seeing the waving only at the last instant, the driver is in a quandary whether to stop and further risk missing the train due to the added delay of bringing the bus to a complete stop, taking the fare from the passenger, possibly being distracted from the continuing debate on the best way to the station, perhaps missing the traffic light which for the present moment is green, etc. What to do... what to do??

Well, this metaphor could be substantially developed to further color the picture you may have in your mind. But I think the general idea is apparent.

So it is that I suggested that perhaps the best way for you to get on-board is merely to extend your arm in hopes of grabbing some portion of the 'bus.' Either you will wrench the arm from its socket or you will stretch it a bit and then accelerate to match the speed of the bus. That's really the best we can offer at the moment. That is, in effect, here.... catch. If you can handle assignment 'X' with little or no assistance, then come back in 'N' months with it done. Bring us a little surprise package. When we open the box, we merely take out your product and plug it in. If it works, you're a hero. Maybe that means you'll get an 'atta-boy'... but don't hold your breath. For the most part you'll be working in a vacuum or with whatever support you can develop locally. Until the management at HQ can recover from the Phase IIIa Project, we can realistically expect very little

Still interested. Super! Your first assignment is to formulate a Document Library of every conceiveable, applicable document that we might need to design and evaluate a Protocol for AMICON. This library shall contain both professional and Amateur journals and documents. Beyond this, you're on your own. And as far as time for completion, the sooner the better is the rule again. I would like to have a listing of the documents in the AMICON Library in 30 days. Can you do it??? Oh yes. One further thing. Part of your volunteer commitment is that the costs incurred enroute shall be zero (as far as AMSAT is concerned). This is where the word hobby starts to lose its meaning or at least takes on some added connotations.

I hope I have given you the straight dope on the way things are (or at least how I see them).

In my next letter I will send the names and addresses of those individuals with whom you may want to develop a rapport. Meanwhile, I wish that you would supply me with some data on what you do at

TRW and what your specialty is (are?). Come to think of it, do you have a resume?

I can't think of a better way to match your skills to a task. Can you?

Are you really prepared to devote ½ hour per day to some AMSAT task? Think on't a moment. Is this the end of a hobby and the beginning of a second job? And one with a pretty lousy salary at that!

One of the problems AMSAT has is 'burnouts.' Persons who, effectively, say: "Gee, I want to do 'so and so' and do it for a while" often very well. Then, for no apparent reason they vanish (as far as AMSAT is concerned) from the face of the earth. Maybe they take up sailing or lechering or some other fascinating hobby. Who knows?

The question is, are you a potential burnout?

We all are, of course. But the real question should be: "At what point will 'so and so' burn out?" The single most important characteristic about those in leadership positions in AMSAT is that they have, in effect, asbestos underwear. They are 'burn-out-proof.' Yet even in the lead ranks we lose some. Well, have you checked your underwear lately? Can you imagine a situation where working at <u>your</u> hobby becomes very much like a task that you <u>must</u> do? Is that a hobby? Is that what you want to do? In other words, if you called me to add to your fun quotient, I can promise you very little of same. On the other hand, if you called me to volunteer to do some real <u>work</u> which may become at times drudgery... yea... even make you wonder if this is what you 'came' for in the first place, ie, fun in Ham Radio and/or computers... THEN I think you may work out fine.

I wish I could give you more of the flavor of what we're about in the AMSAT nucleus (even though I don't consider myself an insider of the 'nuclear' crew, but more a straddler on the periphery... a perspective I value for its 'trees and forest' discrimination-providing-insights.) But I guess you'll get the flavor by osmosis.

73 for now

Rip

Rip
WA2LQQ

Wally Linstruth WA6PJR
2413 Burritt ave
Redondo Beach CA 90378
213 - 542 - 3290

'The Source' TCC 427

Longtime member, non-operating
Ithaca audio Z80 22 48K CPM
NEC Spinwriter
Soroc IQ 120
TRW Satellite Integration & Test

AMSAT
Radio Amateur Satellite Corporation
P.O. BOX 27, WASHINGTON, D.C. 20044

Dear OM,

As the launch day approaches for Phase-III-A plans are being made for an Operations Manual for the newest of Radio Amateur communications satellites. The task of producing it will be spearheaded by Dick Peacock, W2GFF, who has long been involved in contributing his time and efforts to AMSAT. After it is completed we plan to publish this document either as an individual publication or as a future issue of AMSAT's ORBIT magazine.

Since you possess an expertise in one or more of the many subjects which must be covered, your assistance along with a number of others is being requested. Specific subject assignments and topics which must be covered in the Phase-III-A Operations Manual will be listed in an outline which Dick Peacock will be providing to all who accept our call for help.

I hope that we can count on your assistance in contributing to the writing of this very important document.

73, Rich

Richard Zwirko K1HTV
V-P Operations AMSAT

R.J. PEACOCK

9 Andrea Drive
Setauket, L.I., N.Y. 11733

13 May, 1980

Dear OM,

The Operations Manual will address only the AMSAT Phase III-A satellite. The first part of the manual will describe the fixed factors of the spacecraft's equipment and the orbital parameters. Following this, the manual will discuss operational considerations for implementing effective use of the fixed parameters. The final part of the manual will consist of Detailed Operating Standards intended to provide users with coordinated guidelines for realizing the most effective worldwide use of the satellite. These Operating Standards may be revised from time-to-time as practical experience with the operating satellite may require.

The Operations Manual will be in the general format of the following OUTLINE:

- GENERAL
    - Purpose
    - Scope
    - Policy
    - Definitions and Terminology

- TECHNICAL CONSIDERATIONS AND CONSTRAINTS
    - Satellite Systems and Capabilities
    - Orbital Parameters
    - Propagation
    - Operational Lifetime of the Satellite
    - Ground Station Considerations

- OPERATIONAL CONSIDERATIONS AND CONSTRAINTS
    - AMSAT Operations Organization
    - Transponder Band-Plan
    - Satellite Tracking
    - Monitoring Satellite Performance

- DETAILED OPERATING STANDARDS
    - General Beacon
    - Engineering Beacon
    - General Operation
    - Special Services Channels
    - AMSAT Coordination and Network Frequency

A more detailed outline, and subject checklists, will be provided to those who wish to contribute to the preparation of this manual. If you wish to participate, please indicate the subject areas in which you could contribute.

73, Dick

Dick Peacock, W2GFF

OPERATIONS MANUAL

AMSAT PHASE III-A SATELLITE

FORWARD

It is the desire of AMSAT that the satellite be operated in a manner that will provide the maximum usefullness. It is AMSAT's belief that voluntary cooperative adherence by all amateurs to the standards recommended in this manual will assist materially in reaching this objective. From time to time, practical experience with the operating satellite may require revisions to these standards.

OPERATIONS MANUAL

AMSAT PHASE III-A SATELLITE

1.0 GENERAL

1.1 PURPOSE

This manual is intended to promote optimum operational use of the satellite by establishing, and defining for users, appropriate operational and technical standards that are compatable with the orbital parameters and functional capabilities of the satellite.

1.2 SCOPE

This manual addresses those areas of satellite operation that are related to open-access by all amateurs for the purposes of (a) two-way communications through the satellite, and (b) reception of the satellite beacons. Command functions are addressed only to the extent that they involve actions of amateurs outside of the command-station network.

1.3 POLICY

The operational use of the satellite is limited to licensed amateurs throughout the world, in compliance with all applicable regulatory requirements and constraints. Use of the satellite is limited to non-commercial and non-military applications.

The satellite transponder and beacons are licensed to AMSAT Deutschland under the call letters DF0OS. As the licensee, AMSAT is responsible for ensuring operation is in compliance with all regulatory requirements. Ultimate control of the satellite transmitters rests solely with AMSAT.

PRELIMINARY COPY

W2GFF May 9, 1980

OUTLINE

OPERATIONS MANUAL

AMSAT PHASE III-A SATELLITE

Forward

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- 4.3 General Operation
- 4.4 Special Services Channels
  - 4.4.1 H-1 CW and RTTY Bulletins/Code Practice
  - 4.4.2 H-2 Educational Channel
  - 4.4.3 H-3 Voice Bulletin Channel
  - 4.4.4 L-1 Scientific Channel
  - 4.4.5 L-2 AMSAT International Computer Network
  - 4.4.6 L-3 Traffic Channel
- 4.5 AMSAT Coordination and Network Frequency (ACNF)

PRELIMINARY COPY

W2GFF-May 9, 1980

9 Andrea Drive
Setauket, NY 11733

April 2, 1980

K1HTV
W3PK
W3IWI
WA2LQQ

1. Operations Manual-AMSAT Phase III-A Satellite

Intended as a document to be made available to the general amateur public either as an individual publication or as an issue of ORBIT MAGAZINE. The subject is limited to the one satellite, as the technical and orbital considerations will be specific to that spacecraft. The format and operational sections might be essentially the same for use with other birds, however.

The outline and paragraph numbering system is intended to assist in coordinating authorship of the various sections without repeating material covered elsewhere.

Subjects are arranged so that the fixed factors of the equipment on the spacecraft, and the orbital characteristics, are defined initially. Operational considerations discuss how these fixed items may best be utilized, and the optimum overall benefit obtained from the satellite. Specific detailed working standards can be provided on a flexible basis in the final section of the document.

The SCOPE and POLICY sections should be verified at an early stage so that we all know just what limitations and constraints may apply before any controversial subjects are amplified by unsupported assumptions.

2. Checklists

These pages are initial ideas on the more detailed subjects that should be included under the numbered paragraphs as per the outline. In some instances, previously published material that may be adapted to these sections is identified. The parts enclosed in (-----) are not in any precise order, and are not considered complete in any way.

3. Comment

If this whole idea is considered feasible, I would expect that potential authors be identified, and specific subject assignments be listed on a copy of the outline provided to each author. In this manner each author would be able to coordinate with the others to prevent duplication and to know where to direct inquiries regarding interfacing subjects.

73, Dick Peacock, W2GFF

OPERATIONS MANUAL

AMSAT PHASE III-A SATELLITE

1.4 DEFINITIONS AND TERMINOLOGY

Space communications frequently require reference to astronomical terminology and other terms of reference not normally encountered by amateurs. Where such items are used in this manual, the following definitions apply.

(Apogee
Argument of Perigee
Ascending Node
Access
Altitude
AOS
Beacon
Central Angle
Descending Node
Doppler Effect
Eccentricity
Elevation Angle
Earth Radius
EQX
Epoch
Faraday Rotation
Inclination
Increment
Injection
Geostationary
LOS
Downlink
Uplink
Mean Distance
Arc Distance
Node
Orbital Elements
Orbital Parameters
Perigee
Period
Perturbations
Precession
Plane, Equatorial
Plane, Orbital
Semi-major Axis
Semi-minor Axis
Satellite Track
SSP
Stabilization
Transponder
Visibility
Window
Terminator
Apsides, Line of

(Suggested reference: Glossary of Astronomical Terms for the Description of Satellite Orbits, Vol 2, No. 10 of Smithsonian Contributions to Astrophysics; Ashbrook, Schilling, & Sterne)

OPERATIONS MANUAL

AMSAT PHASE III-A SATELLITE

2.0 TECHNICAL CONSIDERATIONS AND CONSTRAINTS

2.1 SATELLITE SYSTEMS AND CAPABILITIES

- 2.1.1 Overview
  - (Design philosophy
  - Engineering and design
  - Administration
  - Liaison with ESA
  - Size
  - Weight
  - Configuration
  - Materials
  - Manufacturing responsibilities
  - Qualification and integration testing
  - Credits to contributing groups/individuals)
- 2.1.2 Block Diagram
  - (Overall satellite-see EDN, Apr. 20, 1976)(or K2UBC, p 4-29)
- 2.1.3 Primary Power System
  - (Solar cells
  - Batteries
  - System Regulators and Controls)
- 2.1.4 Transponder
  - (Block Diagram
  - Frequency Conversion formula
  - Modulation principle (how done without a TWT)
  - Passband characteristic
  - AGC characteristics
  - Overload characteristics
  - Receiver sensitivity
  - Transmitter power output
  - Primary power requirements
  - Overall efficiency)
- 2.1.5 Beacons
  - (Frequencies
  - Modulation sources
  - Keying
  - Controls
  - Power output)
- 2.1.6 Telemetry System
  - (Sensors
  - Encoding system
  - Capability for changing data inputs & format)
- 2.1.7 Antenna Systems
  - (Mechanical description
  - Location on spacecraft
  - Beamwidth & pattern
  - Gain
  - Polarizations
  - Feed lines and phasing
  - Antenna switching)
- 2.1.8 Computer Systems
  - (Overview
  - Block diagram
  - On-board capabilities
  - Ground-controlled capabilities
  - Language
  - Formats
  - Programs
  - Memory
  - Software considerations)
- 2.1.9 Command System
  - (Ground-controlled inputs
  - Onboard inputs
  - Interfaces)
- 2.1.10 Attitude Positioning System
  - (Sensors
  - Torquing devices
  - Onboard controls
  - Ground-controls
  - Monitoring & verification of status)
- 2.1.11 Propellant System
  - (Function
  - Description-Materials, weight, thrust
  - Safe-Arm-Fire circuits
  - Performance)

2.2 ORBITAL PARAMETERS

- 2.2.1 Launch
  - (Site
  - Date
  - Time
  - Launch Vehicle)
- 2.2.2 Initial Orbit
  - (Identify start of Orbit #1)
  - (Inclination
  - Apogee
  - Perigee
  - Argument of Perigee
  - Eccentricity
  - Period
  - Precession)
- 2.2.3 Orbital Maneuvers
  - (Firing of kick-motor/Injection in final orbit
  - Date
  - Time
  - Orbit Number)
- 2.2.4 Final Orbit
  - (Identify start of first final orbit
  - Inclination
  - Apogee
  - Perigee
  - Argument of Perigee
  - Eccentricity
  - Period
  - Longitudinal Increment)
- 2.2.5 Orbital Changes with Time
  - (Anticipated results of perturbations
  - Precession of Argument of Perigee)
- 2.2.6 Formulas for Calculating Orbital Elements
  - 2.2.6.1 Basic Formulas
  - 2.2.6.2 Perturbations and Precession

CHECKLIST, W2GFF, May 9, 1980

OPERATIONS MANUAL

AMSAT PHASE III-A SATELLITE

2.4 OPERATIONAL LIFETIME OF THE SATELLITE

(Factors that will have an effect on the life
of the satellite)

2.4.1 Non-controllable Factors
  2.4.1.1 Orbital Environment
    (Perigee height
    Exposure to radiation/Van Allen Belts
    Sunlight and Darkness
    Stabilization and Attitude in orbit)
2.4.2 Controllable Factors
  2.4.2.1 Operational Factors
    (Overload by users
      Excessive Power
      Inefficient modulation types)
    (Management by Command Stations
      Monitoring of Satellite Condition
      Corrective Actions if required)
    (Uncontrolled Commanding/Loss of Control
      On-board systems malfunction
      Unauthorized access to command system
      Outside interference or jamming
        RFI
        Radiation-Earth sources
        Intentional Jamming)

OPERATIONS MANUAL

AMSAT PHASE III-A SATELLITE

3.2 TRANSPONDER BAND-PLAN

(Based on WA2LQQ June 1979 Newsletter article).

3.2.1 General Communications
3.2.2 Beacons
  3.2.2.1 Engineering Beacon
  3.2.2.2 General Beacon
3.2.3 Special Services Channels
  3.2.3.1 H-1 CW and RTTY Bulletins/Code Practice
  3.2.3.2 H-2 Educational Channel
  3.2.3.3 H-3 Voice Bulletin Channel
  3.2.3.4 L-1 Scientific Channel
  3.2.3.5 L-2 AMSAT International Computer Network
  3.2.3.6 L-3 Traffic Channel
3.2.4 AMSAT Coordination and Network Frequency (ACNF)
3.2.5 Bandplan Schematic

CHECKLIST, W2GFF, May 9, 1908

OPERATIONS MANUAL

AMSAT PHASE III-A SATELLITE

4.0 DETAILED OPERATING STANDARDS

4.3 GENERAL OPERATION

(Uplink frequencies
Downlink frequencies
Bandplan Considerations
Transmission Modes
Effective Radiated Power
Antenna Polarization
Receiving Antenna Gain
Receiver Sensitivity
Propagation Anomalies
Path-loss Considerations
Effects of level of user activity
Operating conventions and practices)

OPERATIONS MANUAL

AMSAT PHASE III-A SATELLITE

4.0 DETAILED OPERATING STANDARDS

4.4 SPECIAL SERVICES CHANNELS

(Identification-Channel Number and Common Name
Channel Frequency Definition
Intended Channel Function and/or Use
Channel Coordination
    User's point of contact at AMSAT, and locally, if any
    Information Dissemination
    General Policies
    Scheduling
    Channel availability and sharing
Technical Standards and Requirements
    (Describe applicable characteristics as necessary to provide proper interfacing between all users.)
    Transmitter characteristics
    Receiver characteristics
    Modulation characteristics
    Transmission rates
    Decoding requirements
    Data formats, conventions and protocols
    Precautions and constraints to prevent inadvertent damage or degradation of satellite
Operational Standards and Requirements
    Operating Conventions and Practices
    Minimizing interference between users
    Licensing Responsibility

CHECKLIST, W2GFF, May 9, 1980

AMSAT
Radio Amateur Satellite Corporation

Address reply to:
Vern Riportella,WA2LQQ
AMICON Coordinator
Box 56
Warwick, N.Y., 10990
10 Apr 80

Hank Magnuski, KA6M
311 Stanford Ave
Menlo Park, CA. 94025

Dear Hank:

Yesterday I received your draft AMICON System Spec, rev 1.00. I'm taking the extraordinary measure of responding within the day and in contrast to my regular M.O. of "management by exception" to express my satisfaction with the initial vector!

Both the direction you have taken and the scope addressed seem entirely appropriate.

In addition, I am well impressed with your apparent perspective on the issues.

There are a couple of minor issues (mostly organizational matters) that need to be adjusted but I will reserve comment on them until next week when I should have a bit more time. You need not wait on these comments, however, before proceeding. The comments to come do not affect the technical direction on which you have embarked.

In sum, then, Hank, so far so good. Please begin now to "flesh it out with some detail,ie, a look at the various permutations of the basic ALOHA CSMAP Protocol, for instance. I don't have the time adequate for a complete technical response regarding the complexity of the HDLC but I believe you to be quite correct in stating that it may be a moot issue given the LSI now available. In fact, as a matter of technical integrity it might be well to spec a specific chip to avoid the hassle of debugging the protocol if S/W were used instead of on e of the new HDLC chips.

Incidentally, to place your efforts further in perspective, you will be pleased to know that the next echelon in the Operations hierarchy is also taking shape. Dick, W2GFF, has put together a very good outline for the AMSAT Phase III Operations Manual. One of the sections in the manual is for the SSCs and their use. You may be further pleased to know that of the SSCs, more real work has been done on them in the past month or two than in the past year and further, that the L2 channel, under you guidance may reasonably be expected to set the standards of performance for documentation with regard to the other SSCs.

The point here is to understand the responsibility of setting precedents (which you are and will be doing).

As promised, I will be ptting you in contact with other key individuals in the AMSAT group. To pave the way, I am sending those indicated below a copy of your most recent submisssion along with with this letter. I want you to all know each other and what you each are doing in hopes that you can cross-pollinate each others work, etc.

For your part, would you please mail a copy of rev 1.0 to Wally, WA6JPR, down in Redondo Beach.

Finally, I will be placing your name in the context of AMICON in various spots in the Amateur media as a resource to be tapped and for questions to be answered. This will occur after one or two more iterations on the Spec (when we are sure that you and I both speak the same language...HI)

Thanks for the fine effort and please express my thanks to Mark, Gary and Gary, your collaborators.

vy 73,

Rip

Rip
WA2LQQ

cc: K1HTV
W3IWI
W6SP
W6XO
W1HDX

Selected AMSAT References for KA6M

K1HTV	Rich Zwirko	AMSAT Director & Vice President, Ops Commercial Broadcast station engineer 34 Montclair Dr, Manchester, Ct., 06040 Home 203-646-5726 ofc 203-522-1080
W3IWI	Dr. Tom Clark	AMSAT Director & Executive Vice President Radio Astronomer with NASA 6388 Guilford Rd, Clarksville, MD, 21029 Home 301-286-3113 Ofc 301-344-5957
W6SP	Col. John Browning	AMSAT Board Chairman Colonel, USAF (Active duty); satellite prog. 6202 Lochvale Dr. Rancho Palos Verdes, CA., 90274
W6XO	Dr. John Pronko	President, Project OSCAR Plasma Physcist, Lockheed Space&Missle 230 Hawthorne Ave, LosAltos, CA., 94022 Home 415-941-6988 Ofc 415-493-4411x45179
W1HDX	Dr. John DuBois	AMSAT Special Systems Consultant President, Dytron Corp. 241 Crescent Ave., Waltham, MA, 02154 Home 617-263-7004 Ofc 617-891-9029
WA2LQQ	Vern Riportella	AMICON Coordinator; ALINS Project Mgr; Phase III Tech Ops Mgr; Mgt Consultant Vice President, National Distributing Co. (Formerly with IT&T and Comp. Sci. Corp.) Box 56, Warwick, N.Y., 10990 Home 914-986-6904 Ofc 201-768-2500

WCVUC
James Eagleson
280 Manfre Rd
Watsonville, CA
95076

3-25-81

Hank Magnuski KA6M
Menlo Park, CA

Dear Hank,

I was very happy to hear from you in regards to speaking at the West Coast VHF/UHF Conference. For the moment it looks like you will lead off the afternoon sessions with the first talk scheduled for 1:30PM. Let me know if this creates any problems.

Depending on interest generated by your talk, would you also be available to give a Tech Session in the evening if enough people request one? At the very least, it would be good if you had a few handouts briefly outlining your talk and giving information about the 58 repeater and/or packet experimenter groups/standards.

You might come to the April 11 Project OSCAR meeting and give input on SYNCART's digital channel/standards and the terrestrial Linear Translators.*

For the sake of my own enlightenment, could you send me a rundown on bandwidth requirements for packet radio as you now use it? I presume FM is used currently on Two Meters. Can FSK (as opposed to AFSK) be used to narrow the bandwidth to allow a savings in spectrum when using Linear Translators(LT's)? This would be important in multiple channel/multiple use LT's such as the NBC machine and the Project OSCAR L.T.

Hope to see you April 11th.

73, Jim E.

* Oops, I see you're already on the schedule.

PROJECT OSCAR *Inc.*

April 17, 1981

Dear Hank,

Just a quick reminder that the VHF/UHF Conference is less than two weeks away. Don't let May 2nd sneak up on you!

If you have slides or viewfoils, we will provide a screen, overhead projector, and Kodak Carousel 35mm slide projector. Those in the evening Tech Sessions, however, may wish to provide their own, if required.

If you have handouts, please give them to me, Paul Shuch, or whoever we may designate so that we can get them passed out promptly. Give them to us a few minutes before your talk or earlier.

Enclosed is a program preview. We have a good set of topics with a mix of "tried-and-true" speakers along with some "new" blood...all but one of them Radio Amateurs.

If your topic generates great interest you may wish to schedule an evening Tech Session. These are informal sessions allowing conferees to explore new ground with various "experts".

I looking forward very much to hearing your talks. Seems like some new things are happening and some old ones are getting some second looks!

73,

Jim Eagleson (LB)

Jim Eagleson, WB6JNN
Program Chairman

P.S. We will be in 'Chardonnay' for daytime presentations (seats about 180) and have 'Gamay' 1 & 2 for the Noise Figure and Tech Sessions. We also have a hospitality suite for smaller Tech Sessions.

TECH SESSIONS

ACSB & ALTERNATIVE SSB TECHNIQUES- Fred Cleveland, WB6CZX, will present material for the Amateur experimenter in this area.

ANTENNA MEASUREMENTS & TECHNIQUES- Mike Stahl, K6MYC, will discuss new IEEE methods of measurements, and the general techniques of VHF/UHF/Microwave antenna design and feeding.

GASFETS-DC TO BLUE LIGHT- Chip Angle, N6CA, will fill us in on details of the use of these not-as-expensive-as-they-were devices.

OSCAR SATELLITES-HOW TO USE THEM- Ross Forbes, WB6GFJ will lay out the requirements for a well equipped OSCAR station.

PC BOARD DESIGN AND ETCHING- Jim Eagleson, WB6JNN will show and tell how to lay out PC boards and etch them(and tin plate them).

VHF SYNTHESIZERS & PLL L.O. DESIGN- Jim Pinnel, N6BIU, will fill us in on various sythesizer techniques for transcievers, signal generators, and microwave L.O.s

LINEAR TRANSLATOR DESIGN & CIRCUITS- For those interested in following up on the progress and evolution of L.T.s, Jim Eagleson WB6JNN will discuss design and circuits of the Two Meter and SYNCART L.T.'s.

SPECIAL- Other sessions may be scheduled based on interest and availability of space/speakers.

PROJECT OSCAR *Inc.*

WEST COAST VHF-UHF CONFERENCE-1981 PROGRAM PREVIEW

The 26th Annual WCVUC will be held at the Sunnyvale Inn on May 1st through 3rd. Formal seminars will be held during the daytime hours on Saturday, May 2nd, with informal Tech Sessions scheduled during the evening hours.

Seminars include:

TVRO SYSTEMS-THREE ROADS TO SATELLITE TV RECEPTION:

Jay Schaefer, W6BWB, of Teleprompter, Inc. will present the commercial approach to TVRO reception.

Mike Stahl, K6MYC and/or Mel Farrer, K6KBE will discuss KLM's commercially available home reception system.

Tay Howard, W6HD, will share techniques appropriate for the home experimenter.

1296 STATE-OF-THE-ART, 1981:

Joe Cadwallader, K6ZMW, with a little help from Chip Angle, N6CA, will outline various up-to-the-minute work they have been doing on the 23cm (1296 MHz) band. Gasfets, High Power amplifiers (like, 200W!), and related topics will update us on what can be and is being done on this band. This is especially relevant considering the possible 1260 MHz input on Phase IIIB and the primary 1260 MHz input on SYNCART.

ACSB-AN ALTERNATIVE TO WIDEBAND FM:

We tend to think of our Two Meter FM operations as NBFM, ie, Narrow Band F-M. Dr. Bruce Lusignan of Stanford University's Satellite Planning Center will demonstrate ACSB, Amplitude Compandored Sideband, an SSB based system using amplitude compression and expansion along with a pilot carrier to provide performance equivalent to NBFM but with less than 5 KHz channel spacings. This includes AFC, Squelch, very fast AGC, good fidelity audio, improved signal-to-noise performance, and effective quieting performance.

PACKET RADIO-DIGITIZED COMMUNICATION:

Hank Magnuski, KA6M, has authored several articles about this new field within Amateur Radio. He will lay out the what and how to in this talk concerning communications between terminals and/or computers via Amateur Radio.

As Hank is involved in the S.F. Bay Area simplex, packet repeater, he will present the potential of this as well as satellite translated packet communications. SYNCART, for example, will have a special channel dedicated to packet communications.

THE NEW OSCARS-UOSAT, PHASE IIIB, AND SYNCART:

For the first time we have three Amateur satellites on the horizon offering three, very different kinds of service.

Late this year (Sept 1981) we will see the launch of UOSAT, the United Kingdom's first Amateur satellite. It will also be the first Amateur satellite dedicated solely to scientific experiments.

About the middle of 1982 should see the launch of Phase IIIB, the replacement satellite for the one lost in a launch failure last year. This high-altitude, polar orbit satellite will provide transcontinental communications (spell that D-X) for up to eight hours each day.

Late in 1983 or 1984 should see the launch of SYNCART, the first satellite built by Amateurs specifically for synchronous orbit. This transponder (actually to be part of a commercial or government satellite) will provide 24-hour coverage of most of North and South America and will have special digital and bulletin/emergency channels in addition to the main communications channel. Canada and West Coast amateurs are developing hardware for SYNCART as well as terrestrial linear translators for testing ideas and possible uplink use.

Dr. John Pronko will call on others to aid him in presenting this talk. John, of course, is president of Project OSCAR, one of the organizations developing SYNCART.

USING AND MAKING DOUBLE BALANCED MIXERS:

These handy items are expensive to buy but have a variety of uses not recognized by many experimenters. Andy Olson, N7BST, of Summit Engineering will call on his experience in the manufacturing of DBM's to show us how to make VHF/UHF and Microwave DBM's as well as demonstrate their applications versatility.

THE CARE AND FEEDING OF YOUR VHF/UHF STATION:

Louis Anciaux, long before he was known as proprietor of Lunar Electronics, was known as an active experimenter on all VHF and UHF bands (including 23cm). He is going to share his thoughts on Noise Figure, Compression Point, system matching, receiver and transmitter facts and fallacies, amplifier linearity, antenna stacking calculations, and anything else that comes to mind that may be important to the fine tuning of the state-of-the art station operating above 50 MHz.

In recognition of the wide range of interests and experience represented at each year's conference, this year we are providing a new program...the evening Tech Sessions.

Concurrent with the Noise Figure Measurements on Saturday evening, we will be scheduling half-hour, informal sessions during which various experts will present some aspect of VHF, UHF, or Microwave experimentation or technique.

Some of the offerings include:

Using the OSCAR Satellites--Ross Forbes, WB6GFJ
ACSB & Alternative SSB Techniques--Fred Cleveland, WB6CZX
GASFETS--The Price Is Right(finally)--Chip Angle, N6CA
ANTENNA Measurements & Feeds--Mike Stahl, K6MYC
PC BOARD Layout and Etching--Jim Eagleson, WB6JNN
VHF SYNTHESIZERS & PLL L.O.s--Jim Pinnel, N6BIU
LINEAR TRANSLATOR DESIGN & CIRCUITS--Jim Eagleson, WB6JNN

Plan to attend. Pre-registration deadline is April 15th.

PRE-REGISTRATION FORM (Deadline April 15, 1981)

NAME____________________ CALL____________

ADDRESS______________________________

CITY__________________ STATE______________

ENCLOSED FIND: $________ FOR ______(qty) registrations($5.00)
$________ FOR ______(qty) Cookout Registrations ($8.00)

SEND TO:

West Coast UHF Conference
P.O. Box 5283
San Mateo, CA 94402

8:15-8:40AM	REGITRATION
8:45-9:10AM	ORIENTATION
9:15-10:00AM	TVRO-THREE ROADS TO DIRECT SATELLITE TV Jay Schaffer, W6BWB, Mike Stahl and Mel Farrer, K6MYC & K6KBE, and Tay Howard, W6HD, will join forces to discuss CATV, commercial home, and experimental home reception of satellite TV.
10:00-10:15AM	COFFEE BREAK
10:15-10:55AM	1296 MHz-STATE OF THE ART, 1981 Joe Cadwallader, K6ZMW, brings us up to date on what's happening on this band including information on GASFET preamps and 200W amps.
11:00-11:45AM	ACSB-A 5 KHz ALTERNATIVE TO NBFM Dr. Bruce Lusignan, Director of Stanford's Satellite Planning Center, will tell us about the SSB based system he has developed for Land Mobile. The implications will be obvious!
11:45-12:00AM	LATE REGISTRATION/NOISE FIGURE/ANTENNA REGISTRATION
12 NOON-1:30PM	LUNCH BREAK
1:30PM-2:10PM	PACKET RADIO-DIGITAL COMMUNICATIONS Hank Magnuski, KA6M, will discuss simplex terminal to terminal/computer repeaters, data transmission techniques generally, and satellite data transmission.
2:15-3:00PM	THE CARE AND FEEDING OF YOUR VHF/UHF STATION Louis Anciaux, WB6NMT, will go over Noise Figure, preamp gain, Compression Point, system matching, amplifier linearity, antenna stacking information and other factors needed to fine tune your station.
3:00-3:15PM	BREAK
3:15-3:55PM	THE NEW OSCARS- UOSAT, PHASE IIIB, SYNCART John Pronko, W6XN, will give out up-to-the-minute information on the three satellites each providing different functions due to be launched in 1981-84.
4:00-4:40PM	MAKING AND USING DOUBLE BALANCED MIXERS Andy Olson, N7BST, of Summit Engineering will call on his commercial experience to provide a "how-to" and "what-to" talk about these versatile devices.
4:45-5:30PM	DRAWING FOR PRIZES/LATE REGISTRATION(NF/ANT)

AMSAT

Radio Amateur Satellite Corporation

P.O. BOX 27, WASHINGTON, D.C. 20044

March 15, 1981

Amount of Contribution: $50.00

Mr. H. S. Magnuski
311 Stanford Avenue
Menlo Park, CA 94025

Dear Hank:

First I would like to thank you and officially acknowledge your gift to AMSAT's 1980 mailing to Life Members. As of the date of this letter, 644 members have responded by donating a total of $30,310. $28,391 of these gifts is being applied to the matching funds adminstered by the ARRL Foundation, while $1919 will be used for AMSAT's operations. Thus, the response to our mailing has been truly fantastic! You cannot believe how much the AMSAT team appreciates your support.

Even more encouraging than the financial support which you and our other Life Members have shown were the responses to the questionnaire. Almost all the responses were extremely detailed, thoughtful and helpful. We hear you! We hope to summarize the responses in more detail soon in Orbit, but here are a few preliminary inputs. The prevailing thought was "Push Ahead!" A number of respondees said "Your plans and endeavors cannot be too ambitious. We look to you for leadership." The questionnaire asked for your preference for Mode A in low altitude orbits versus higher frequencies in high altitude orbits. The response favored high altitudes by about 3 to 1, but with a strong advocacy for the continuation of some Mode A for entry level activities. Most respondees were supportive of Orbit with lots of good constructive criticism while urging fiscal responsibility. In summary, the inputs were carefully thought out and provided some most welcome feedback from you, the backbone of AMSAT.

At this time, although the scheduled launch is just about one year off, Phase IIIB construction is in high gear, which means that we are spending almost $800 a day! Thus, our new fund raising programs are crucial and time is of the essence if we are to remain on schedule.

Among these programs is our "Hams-in-Space" T-shirt campaign to be launched on Friday, April 24, 1981, at Dayton and which we hope will raise as much as $100,000. One AMSAT supporter has already contributed the first 2,000 high quality colored cotton "Hams-in-Space" T-shirts. The shirt will be offered as a free premium to anyone who contributes at least $10 to AMSAT.

If this T-shirt is as well received at Dayton as we hope, our next target will be Field Day, and all Amateur Radio Clubs throughout the country. We hope to mail one shirt to every ARRL affiliated club and every other club that participated in Field Day last year with a plea that the club order at least 15 more shirts.

Obviously, to be successful, we need your support. Specifically, would it be possible for you to sell some T-shirts? I just gave a rough description of the shirt at a club meeting of 30 hams last week and picked up 15 firm orders. You can do the same. We will send you as many T-shirts as you can sell. Just fill out the enclosed form and mail it back in the return envelope. We'll get you the T-shirts no later than the first week of June.

We also need your help at Dayton. As a first step, we expect that every AMSAT support at Dayton this year will turn himself into a walking billboard for the T-shirt program by wearing our T-shirt. (If it is cold or rains again, put the T-shirt on top of your sweater or windbreaker!)

Next we need help to man the several points of sale we are going to set up, and to be effective, we've got to schedule this in advance. Therefore, if you are going to be at Dayton, please let us know and give us some of your time. We need you!

Again, let me thank you for your support and encouragement.

73's
Bill
Bill Brown
K9LF

P.S. By random draw held this week, the winner of our Phase III Support Sweepstakes, winning pristine Collins 75S-3C (round emblem) receiver was Roy Hill, W4PID! Congratulations, Roy!

Please return this form to: AMSAT
P. O. Box 27
Washington, D.C. 20044

AMSAT T-SHIRT VOLUNTEER

☐ Yes, I want to volunteer my time to solicit contributions to AMSAT.

☐ Please send me _____ T-shirts which I will give away as premiums to every supporter contributing at least $10.00 to AMSAT. (Suggested amount is 15 T-shirts with solicitation completed and funds remitted by the end of June).

☐ I am unable to solicit donations to AMSAT and distribute T-shirts as premiums at this time, but I would like to contribute $______ more to AMSAT and receive _____ T-shirts as free premiums.

☐ Yes, I can help at Dayton, and I will work for _____ hours on

- ☐ _____ hours on Friday
- ☐ _____ hours on Saturday
- ☐ _____ hours on Sunday.

☐ I promise to become a walking billboard for AMSAT, and I will wear my T-shirt at <u>all</u> events with my fellow hams.

Signature ______________________________

Please Print Name and Call Sign.

Name ______________________ Call Sign ______________

Address ______________________________

City ________________ State ____________ Zip Code ______

Phone ____________________ Date ____________________

Contributions to AMSAT are tax deductible in the United States by Treasury Ruling

PROJECT OSCAR Inc.

AMATEUR RADIO SATELLITE ENTHUSIASTS

PROJECT OSCAR Inc.

PO BOX 1136
LOS ALTOS CA 94022

PROJECT OSCAR GENERAL MEETING

TIME: Saturday - April 11 , 1981 12 noon to 4 P.M.

PLACE: Harry's Hofbrau at the Palo Alto golf course/airport.
(Located in the same building complex as the pro shop and within walking distance of the airport tiedowns)

Talk in on WA6YCZ/RPT - 147.15 MHz and 224.94 MHz

Come join us! Everyone welcome! Spread the word! Get to know the satellite crowd! Learn more about the amateur radio satellite program! Get involved! Be part of the amateur radio space age!

Program: Social hour from 12:00 to 1:00 P.M. An excellent-reasonably priced-lunch selection (cafeteria style) and a no host cocktail bar will be available the entire afternoon.

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: Report on present projects:-
- a) AMSAT OSCAR 7 AND 8 orbital calendar - John Pronko W6XN
- b) The 23cm linear translator - James Eagleson-WB6JNN
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: Movies of the Ariane launch vehicle and ESA's Kourou, French Guiana launch facility - Robert Shutak, Grumman Aerospace Corp.

: Elections for 7 Board of Director positions.

The following have been nominated as candidates for membership on the Board of Directors for the next two years:-

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John Pronko-W6XN
John Fail-KL7GRF/6
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A Board of Directors meeting will be held immediately after the main meeting.

John

John Pronko-W6XN
President -- Phone (415) 941-6988

PROJECT OSCAR, INC.

PRESENTS THE TWENTY-SIXTH ANNUAL

WEST COAST UHF CONFERENCE

1 - 3 MAY, 1981

SUNNYVALE HILTON INN
1250 Lakeside Drive
Sunnyvale, CA 94086
(408) 738-4888

TECHNICAL PROGRAM includes lectures, panel discussions, and informal group meetings, covering numerous aspects of UHF and microwave design, fabrication, operation, measurement and test.

EQUIPMENT EXHIBITS will include the finest in UHF and microwave gear, from ATV to Linear Translators to Tropo to Moonbounce to Meteor Scatter, and even the latest in OSCAR spacecraft designs.

ANTENNA MEASUREMENTS will be performed in the amateur 70cm, 23 cm, 13 cm, 9 cm, 5 cm, and 3 cm bands. Antennas entered should be compatible with a 50-ohm measurement system, and you must be able to <u>hold</u> your entry.

NOISE FIGURE MEASUREMENTS of receive converters and preamplifiers will cover all of the above bands. Converters must have a 28 - 30 MHz IF output. Preamps will be measured into converters of known noise figure. DC power supplies, covering 12 to 28 VDC, will be furnished.

ACCOMODATIONS are available at a substantial discount, but reservations must be received by the Hilton no later than 15 April 1981. Use the reservation card enclosed.

REGISTRATION for the entire conference is $5.00 in advance, or $8.00 at the door. For advance registration rates to apply, you <u>must</u> send your check and the form below by April 15th. Walk-in registration at the Hilton will run from 7 to 9 PM on Friday night, and start at 8 AM on Saturday. No-host bar will be open Friday night, with the first session starting at 8:45 AM Saturday.

SPECIAL LUNCHEON EVENT: By overwhelming popular demand (two people asked), we are pleased to offer the FIRST INTERNATIONAL MICROWAVE COOKOUT, at Noon on Saturday, 2 May. Bring along your 1296 rig and barbecue some of your favorite hams. The $8.00 fee will include tax, tip, and all the ergs you can eat. Reserve early, as this is the social event of the season, and tickets are sure to sell out at least several minutes in advance!

PRE-REGISTRATION FORM (Deadline 15 April 1981)

NAME ____________________ CALL ____________

ADDRESS ______________________________

CITY ________________ STATE ______ ZIP ____________

SEND YOUR CHECK TO:

West Coast UHF Conference
P. O. Box 5283
San Mateo CA 94402

ENCLOSED Find $ __________ for ______ (qty) Conference Registrations, at $5.00 ea.,

and $ __________ for ______ (qty) Cookout Reservations, at $8.00 each.

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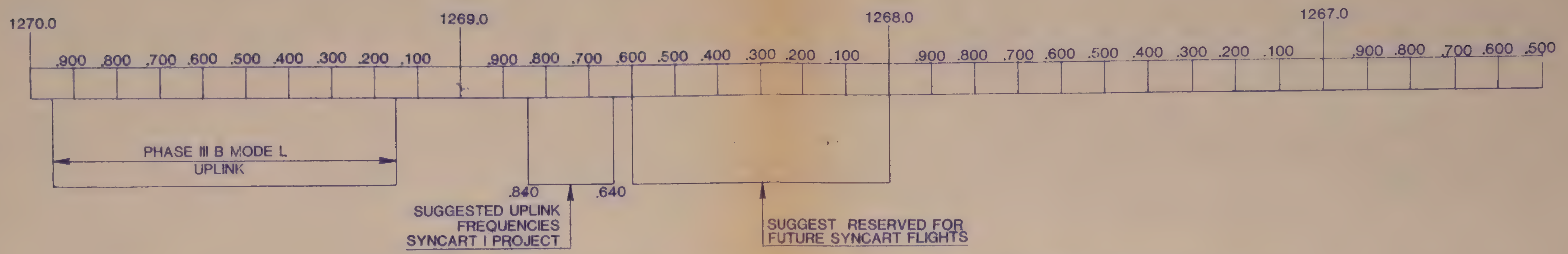
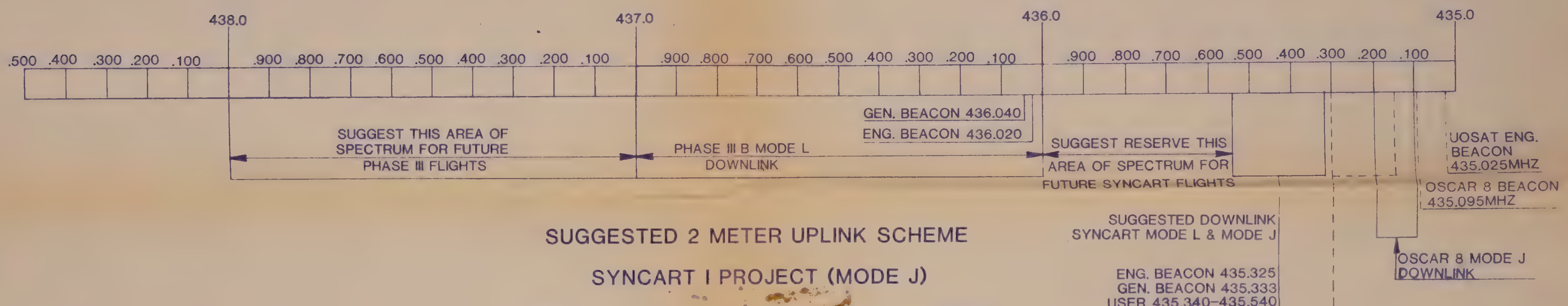
John
John Pronko-W6XN
President -- Phone (415) 941-6388

SUGGESTED 1200MHZ UPLINK SCHEME SYNCART I PROJECT (MODE L)

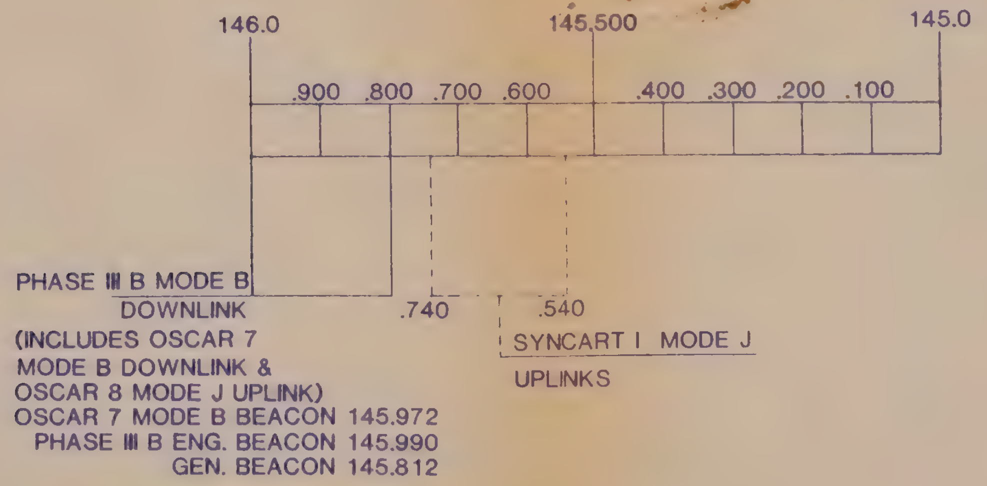


SUGGESTED 435MHZ DOWNLINK SCHEME SYNCART I PROJECT (MODE J & L)



SUGGESTED 2 METER UPLINK SCHEME

SYNCART I PROJECT (MODE J)



SUGGESTED MODE & FREQUENCY SUMMARY SYNCART I PROJECT

UPLINK MODE J	145.540 TO 145.740
DOWNLINK MODE J/L	435.540 TO 435.340 ENG. BEACON 435.325 GEN. BEACON 435.333
UPLINK MODE L	1268.640 TO 1268.840

COMMAND & CONTROL FREQUENCIES TO BE DETERMINED

DATE ______ ______________________

J.E. FAIL PROJECT MANAGER

SYNCART DIGITAL GROUP
6170 DOWNEY AVE
LONG BEACH, CA 90805
213-531-4852

PROJECT OSCAR *Inc.*

RF GROUP REPORT

12-23-81 je

Well, a lot has happened since our last short news report.

1. Jan King of AMSAT visited the Southern California Project OSCAR group after discussing launch prospects on a TRW/DOD satellite. About 30 people attended as Jan reported that prospects were good to get aboard this 1984 launch. Later discussions with officials in Washington, D.C. have been favorable as well.

2. Bob Stein, W6NBI, has improved his 435 driver amplifier design so that input and output match are now very good, indeed, while maintaining 29dB of gain and 35dBc IMD.

3. Jim Eagleson, WB6JNN, is putting finishing touches on a new 10.7MHz, 80dB gain, IF Amplifier to replace the very early prototype unit that was used in the original Project OSCAR 23-cm Linear Translator. This LT is being refurbished for re-installation on MT. Umunuhm in mid January.

4. Paul Shuch, N6TX, and Dennis Finkledei, K0JHI/6 will be meeting immediately after the holidays to make a PC board layout and build an integrated Up-Converter and L.O. for 435 MHz.

5. Ray Maxwell, WA6VAB, has promoted the promise of a crystal oscillator module from a major crystal maker which, hopefully, will arrive in time for the installation of the LT.

   Ray has been less successful promoting badly needed ATC Chip Caps (100pf and 250pf needed). Anyone knowing where we can get these at less than 100 quantities and $2.00 a piece, please let us know!

6. John Henry, VE2VQ, called Jim, WB6JNN, to apologize for missing his shipping date on sending the SYNCART 30 MHz prototype IF unit. A key person on the project scheduled to do the final evaluation was out sick for about three weeks.

   John Pronko, W6XN, indicated that this IF unit arrived in the mail today (12/23/81).

So much for the local progress.

Now for the news from Washington!

Jan King, W3GEY, AMSAT's VP of Engineering called Jim, WB6JNN about the DISCUS opportunity for a 1984 launch to provide further details.

While this launch does not fulfill many stated goals of the SYNCART concept, it is an excellent opportunity which Project OSCAR intends to support both technically and organizationally.

The following summarizes Jan's comments:

1. This is to be a simulation craft, ie, a dummy payload designed to test the space frame and stabilization system as well as launch techniques. (More the launch technique, I think, since I believe this is to be a Space Shuttle launch...though Jan didn't say since I didn't ask)
2. There will be rigid physical specifications of size, weight, shape, and even resonant qualities of all modules on board.
3. It will allow ample room and weight for considerable equipment.
4. We must supply power (about $20,000 for solar arrays) and attitude control.
5. We may be limited to the two dish antennas aboard or we might have relatively free-reign. This can mean anything from less than optimum to better than expected performance in this area.
6. DOD rules do not allow a non-military payload to be launched into synchronous orbit and though this might be waived due to the simulation nature of the launch and the non-commercial nature of our experiment, it is likely that a drifting (near synchronous) orbit will be required to meet this rule.
7. A drift orbit means a slowly moving equatorial coverage of 1/3 of the earth giving days in any one area but also available only 1/3 of its cycle. In other words, a given station might see the satellite for 2 or 3 days but would have to wait 6 to 9 days before getting another 2 or 3 days of use. This cycle could be 1 day on, 2 days off or 1 week on, 2 weeks off, depending on the drift rate.
8. This puts the craft into two categories:
   1) Expensive..we must provide everything but the main space frame
   2) International..the craft will circumnavigate the globe once each cycle, whatever that cycle may be.
9. European Amateurs, lead primarily by AMSAT DL, are very adamant about using a single IF transponder. Both AMSAT US and AMSAT DL insist that the statistical analysis of Linear Translators with 25 or more simultaneous users precludes the need for individually AGC'd IF's. Project OSCAR has as one of its project goals a laboratory study of this including spectral analysis of Phase III's downlink. My personal feeling is that while this is true when everyone is using SSB (low duty cycle), rampant use

of carriers swept across the passband on earlier satellites (people trying to "find themselves") presents an essentially multi-tone input whose PEP output will reduce the levels of weaker signals more than would occur on a multiple IF system. The multiple IF system provides a lower occupancy rate per IF making the likelihood of several carriers occuring simultaneously in any given passband less likely. We'll see.

10. Obviously, the Two Meter frequencies originally picked for SYNCART are no longer valid due to European useage of 145.5-145.8 for repeaters, among other things.

11. Use by low powered stations using large antenna arrays is complicated by the drift orbit. Use of TVRO dishes, for example, is less practical as realignment would be required frequently (depending on the drift rate). Fixed arrays would be out. Seperation of Two Meter Uplink antennas from 435 MHz downlink antennas to provide isolation from Crossmodulation and Desense is less practical.

BUT...

12. The satellite will provide much greater DX opportunities since it will tie together East Europe, Asia, and the Pacific for a period of time, the Pacific, US, South America and the Atlantic for a time, the US, Atlantic, and Western Europe for some period, etc.

13. Stations located in the Southern Hemisphere will be provided DX opportunities not provided them by the Phase III orbit. Though the percentage of hams in these areas is not high compared with the worlds total, if <u>you</u> are among the 5% that is left out by Phase III but covered by the "Drifter", you might find it a real plus. (It may be more than 5%, by the way).

14. The "Drifter" and Phase III could be interlinked via ground-based translators or directly (less likely due to antenna orientation) for extended coverage. I'm not sure that this will be a plus if Phase III and the "Drifter" have as much use, individually, as I expect since once a bucket is full, it's full!

15. With no other transponders on board and a reasonable antenna situation, both a 23CM/70CM transponder (Mode L) and a 70CM/2M (Mode B) transponder could be used. This would eliminate the need for seperate antennas mentioned in #11 above, and greatly increase the useage of the downlink for demonstrations and educational purposes. Low power emergency work, though requiring higher initial cost for 435MHz equipment (TX), will be very practical during the satellite's access window (though not as good as with a full-time, fixed position craft).

WHERE DOES THIS LEAVE PROJECT OSCAR AND THE SYNCART PROJECT?

Obviously the practical situation is that we assemble a Phase III-type transponder into the DISCUS satellite. It provides very high efficiency, is already developed, will have "experience" by the 1984 launch date (via Phase IIIB), and is a circuit known to AMSAT's technicians. When I say "we", I'm referring to AMSAT and the Amateur Satellite community.

AMSAT is proceding along these lines. They have assumed the direction of the project (co-ordination, that is) but are looking to OSCAR and AMSAT Canada for development of several additional modules to add to the system:

1. PACKET TRANSPONDER It is desired to include a semi-protected Packet radio channel or channels. This could be done totally at IF frequencies and will be injected into the integrating port of the Phase III EER/High Efficiency system.
2. NARROW BAND COMMUNICATION CHANNEL It is desired to provide a semi-protected channel for net, bulletin, educational, and emergency communications.
3. EXPERIMENTAL CHANNEL It is desired to provide a data gathering or dessiminating channel for experimental and/or scientific uses.

Knowing this, Project OSCAR wishes to place full support behind this project and will work towards providing the modules requested. In as much as we hope to re-activate the BATTG/OSCAR 23cm LT in January, development of the packet aspects can commence shortly thereafter since KA6M has expressed desire to use it to further develop packet techniques (Hank, KA6M, is the packet radio man in the SF Bay Area as well as in AMSAT).

As soon as Phase III transponder technical data is forwarded to us from Jan King (he is sending it), we will design appropriate interfaces and techniques to accomplish 1-3 above.

On the other hand, knowing that a few synchronous possibilities have suffered the "not ready" problem in the past, we will also continue development towards a SYNCART transponder. We also have several experimenters like Jim, N6BIU working on user-related equipment for 23cm and hope to provide input relating to "transfer" translators and "gateway" translators.

Keep plugging away!

73,

Jim WB6JNN
Tech Director

800518 RJC

12708 Circle Drive
Rockville, MD 20850
3 June 1980

COMMENTS ON "AMICON SYSTEM SPECIFICATION", DRAFT REV 1.01

Clearly a great deal of effort has been expended on this Specification. It is hoped that the following comments can be used to further this project. While the thrust of the Specification seems specific to channel L2 of AMSAT Phase III, it is bound to see use elsewhere, and these comments are in light of this broader view. The comments will be keyed to specific paragraph numbers, where appropriate.

1.3 Carrier and Modulation Specifications

It would seem that differential phase shift (phase reversal) keying would be optimum. This would be coupled with NRZI (change on zeros), so that absolute phase reference would not be required, each reversal would represent a zero.

1.4 Transmission Timing

It would seem that the comment, in "t0", about the channel being free before transmission commences may be in conflict with some Link Level protocols that are discussed later.

There would seem to be a high likelihood of conflict between the last paragraph of this section (requiring station identification to be prepended to the packet) and the use of maximum packet durations in the order of one second. Even at thirty words per minute, a six-character identification would take 1/30th of a minute; two seconds. Since identification need be given only ever-so-seldom, perhaps a free-for-all identification period ought to be added to the protocol for use every five or ten minutes. This would seem to be within the letter, if not the spirit, of the rules.

2.2 Transmission Code

It would seem that bit stuff and removal, per HDLC, should be mentioned here.

2.3 Channel Multiple Access Protocol

With the narrow channel envisioned (say 1200 bauds signalling rate), there would seem to be few times that Pure ALOHA would satisfy. Presumably the "Simple ALOHA" is my "Pure ALOHA". Much more will follow on this subject.

2.3.1 Definitions

See above section concerning "Simple ALOHA".

2.3.3 Control Using the Simple ALOHA Algorithm

Many people have shown that Pure ALOHA becomes unstable when the offered load reaches 18% of the raw channel capacity. As this figure is approached the delay becomes very long. The criterion of 20% is wildly optimistic.

2.3.3.1 Simple ALOHA Transmission Control

The inclusion of carrier sensing converts the protocol from Pure ALOHA to a Carrier Sense Multiple Access (CSMA) protocol. The "ALOHA" described in the Specification is more properly called 1-persistent CSMA. Sherman, et al., Data Communications, July 1978, show that 1-persistent CSMA equals slotted ALOHA (maximum throughput 36% of bit rate) when the propagation delay is one-fourth the packet duration; these are the conditions to be expected in Phase III. CSMA is poorer than slotted ALOHA for a larger delay/packet duration ratio, becoming worse than Pure ALOHA when the delay is 8/10 of the packet duration. Also, the limitation of the acknowledgement window size to one will result in a lot of small ACK packets, which will waste system throughput. Are ACKs done at the Link Level? How?

2.3.3.2 Simple ALOHA Retransmission Control

The proposal for retransmission is really p-persistent CSMA. It, too, doesn't help much with packets that are not much longer than the propagation delay. Why should we use a different protocol for retransmissions than for the first transmission? Is this complexity necessary?

2.3.4 Control Using the S-ALOHA-CLC Algorithm

The suggestion of synchroniztion slots by use of WWV is interesting. Since stations can easily compute the ionospheric propagation delay between themselves and WWV, they should be able to get withing twenty milliseconds or so of true synchronization. Likewise the delay difference to the satellite from a station at the subsatellite point and one on the limb of the Earth should be less than ten milliseconds - for a total synchronizing error of about thirty milliseconds as seen by the satellite. This seems very acceptable with one-second slots.

3.1 Datagram Network Characteristics

Why should we use datagrams? It would seem that their main function is to combine all of the functions normally provided at Link and Network levels, into the Transport level (level 4). How does one use tandem links with the proposal? Could I originate a packet on a local two-meter link and have it pass through an intermediate station, then through the satellite, back to another station and then onto another local link to the destination station? I think most of these functions are ordinarily provided by the layering of Network levels to connect the various dissimilar Link levels in tandem. I feel that too much is put off to be

fixed at the Transport level, so that one loses the benefits of layering. If flow control is put off 'till Layer 4, I forsee a buffer management problem at the lower layers.

3.2 Packet Format

This is where the above comment becomes obvious. All of the packet, up to and including the Load Control Byte, and starting at the CRC to the end, are properly a Link Level frame. The HDLC address and control fields have not been used at the Link Level, nor do is it proposed to use the control field at the Network level.

Not using the address field (at the Link level) wastes the address recognition feature of the HDLC chips, and imposes considerable overhead on the higher level by servicing of packets intended for other stations. Normally the Link Level address(es) would be of the two parties to a link level exchange. These (might) be the officially assigned call letters of the parties to the link. Similar addressing must be provided to the Network and/or Transport Level(s), since the Link Level addresses may just point to way-points on the path between the end-to-end addressees.

3.3.1 Packet Node Addressing Syntax

The Network level addressing proposed is truly wonderous. Mere mortals shouldn't comment on work of this magnitude, however --- what does one propose to do about acknowledgements in a multiply addressed packet? Is this sluffed off to the Transport level like all the other hard things?

4. Interface: Applications

Ordinarily level 4 is called the Transport Level, and the proposal certainly expects it to perform a lot of functions. The Application level is level 7, with the Session (5) and Presentation (6) Levels in between.

General Comment

Perhaps one should give more attention to some of the protocols mentioned by Lam (IEEE Trans. on Comm., Oct 79). In particular he describes a protocol in which time on the satellite is divided into a fixed sequence of N slots, repeating regularly. A station uses a CSMA protocol to capture one train of these slots. This is a trick which effectively makes the packet durations much longer (and interleaves them) so that the long Earth-Satellite-Earth delays don't wreak as much havoc. Since the Specification has shown how easy it should be for hams to synchronize their time bases, this approach looks attractive. It does strictly limit the number of active pairs or groups of stations to N, at any instant; however the datagram (or X.25 Quick Select) approach could spread this across many more stations. Obviously N would have to be widely published and strictly adheared to. I suspect a value of N = 4 to 8 would be all that could be tolerated. Remember

that each train of slots only returns 1/N times the channel bit rate (though all N trains give this value simultaneously).

I'm really interested in the general subject of ham packet radio. Please keep me up to date on your progress.

73,

Bob

Robert J. Carpenter, W3OTC

AMSAT
Radio Amateur Satellite Corp.
P. O. Box 27, Washington, DC 20044
Telephone: 301-589-6062

Dr. Thomas A. Clark, W3IWI
President

25 September 1982

To: Distribution (see list)
From: Tom Clark
Subject: October AMSAT Packet Radio Meeting

Fellow Packeteers and afficianado,

I've talked with most of you individually the past few weeks to discuss AMSAT's need to get our act together quickly on several packet radio items. In our individual discussions, we have talked about the topics that need resolution and about the proposed meeting schedule. This letter is intended to solidify those plans and give you some ideas to chew on before we get together.

WHEN & WHERE

The date we have picked for the meeting is October 8. This is the Friday before the weekend of the AMSAT Annual General Meeting (AGM), so the chosen venue is the Washington area. I plan that we meet all day (and well into the night if necessary) Friday, and if necessary continue Saturday morning. Saturday afternoon is taken up with a technical forum for AMSAT's users. Saturday evening is free if more time is needed. Sunday is the time for the AGM which will follow a slightly different format than previous AGM's, starting earlier and ending earlier. Therefore, the entire weekend's schedule will look something like:

Fri.	8 October	10:00 to ????	Packet meeting at AMSAT laboratory at NASA/Goddard (or possibly some meeting room at Goddard).
Sat.	9 October	09:00	(If required) Packet meeting, cont'd.
		11:00	Informal/eyeball QSO/show 'n tell on technical items at Johns Hopkins Applied Physics Lab (APL). Hope to show VADG and TAPR TNC's "on the air" at this time.

-- 13:00 -- Technical Forum at APL. Topics will include: What is required to get on Phase-3?. How do I track it?. How do I get on L-Band?. What are the band and operations plans?. How will bulletins be transmitted? What about digital and packet transmissions. AMICON. etc.? What future missions can we expect?

-- 18:00 -- Informal dinner-time get-together at friendly local bistro. Packet meeting could continue if required.

Sun. 10 October -- 09:00 -- All the Sunday festivities are at the NASA/Goddard Employees Recreation Center (where we met last year). Begins with informal swap-fest and eyeball QSO time. Flea market area is available for tail-gaters.

-- 12:00 -- Picnic style lunch at $6.00 per head. includes hot dogs, hamburgers, beer and other normal picnic food.

-- 14:00 -- The AMSAT AGM, including certification of Board elections, reports by officers, etc.

-- 16:00 -- FINIS. everybody goes home.

As you can see, there should be plenty of time for any ad-hoc working groups to get together Saturday and Sunday, so I hope we will end up with enough time to get a lot done. I would recommend that you all bring 2m FM hand-helds with you. Primary liason is on the W3ZM AMSAT repeater, 146.235/.835, secondary on the AMRAD repeater, 147.810/.210.

WHAT

As I see it, we have two major topics to discuss. The first is that the Phase-3B launch will occur early in 1983 (probably in March). The satellite will therefore be ready for operations as the tulips are blooming. In all our planning, we have included the AMICON SSC (Special Service Channel) to accommodate an anticipated requirement for digital linking.

Some of you participated in a telecon meeting a few months ago when some proposed standards were discussed. Unfortunately, there were some "real-world" considerations that were overlooked in your discussions, most important of which was the unsuitability of the present "standard" AFSK/FM modulation (e.g. 202 modems) for a high altitude satellite. In talking with some of you, MSK and PSK have been discussed, but we need to address the question: Should we adopt a standard for the modulation scheme and Baud rate at this time? Since I anticipate that the link standards will be, of necessity, more complex and more expensive than present packet radio practice, perhaps we should consider that Phase-3 be only used to link well-equipped concentrator nodes, and not encourage access by general users. If so, on what time scale can we expect activity to develop? How much R&D is needed before final standards can be adopted? Should we embark on

a concerted effort to develop suitable modems immediately, and if so, under whose auspices? What costs will be involved for such R&D and is there anyone who will spearhead the development and act as project leader? How does Hank's original AMICON specification document have to be updated to reflect the inevitable march of time? Given the Mode-L transponder has 800 kHz bandwidth available vs. 150 kHz on Mode-B, do we want to tackle the Mode-L question at this time, or should we plan that Mode-L will be a logical "home" for experimentation with wider bandwidth techniques? Given that the bulk of packet radio experimentation has been in the US and Canada, how do we meaningfully accommodate the users in the rest of the world?

As you can see, these ain't easy questions, and I think we have a lot of work to do. You'll note that I didn't even mention the X.25 vs. IEEE-802 vs. AX.25 vs. . . . questions -- we still have a lot of work to do on the concepts and time is flitting!

Now to the second topic. It appears that as early as two years from not, we will have an opportunity to fly a low-altitude store-and-forward digital payload into low earth orbit (LEO). We might want to just fly a simple TNC-like single channel device, but I think it is within our grasp to do something a bit more ambitious. This payload would probably involve the AMSAT groups in the UK (Univ. of Surrey/G3YJO) and South Africa (ZS1FE et al). It is likely that the UK group would build the "bus", and that SA would build the digital transponder. The US role would probably involve protocol definition, user interactions, etc. -- in short, we would not build the flight hardware, but would be very heavily involved in the definition and operations aspects.

As many of you know, ZS1FE (a.k.a. KE3D) was with us in Washington for a year and a half, and towards the end of his stay this possibility came to a head. Gordon, Jan King and I have spent a lot of time talking about a possible design which I will present to you when we get together. It basically involves multiple uplinks on one band (70 cm) and a single downlink on another band (2m). I shy away from time-slotted protocols for amateur use because of the difficulties in synchronization with path delays as much as 0.1 seconds (in LEO); but our forte is in using multiple frequency techniques, so my scheme revolves about FDMA augmenting normal packet TDMA techniques. Our situation is complicated because of the fact that different users cannot hear each other, so CSMA is messy. After talking with Den about this, he came up with a paper that described a similar PACSAT system design study, and I have included a copy for each of you to study before we get together.

Den and I have talked about this meeting at length by voice phone and GTE TeleMail, and he has prepared his proposed agenda for the meeting and a list of references. His agenda and mine differ in that he proposes a specific list of topics, whilst I have listed a series of quasi-philosophical questions I'd like to have answered, but they are both intended to reach the same goal. Any of you who wish to propose additional questions, or to revise the agenda, etc. should feel free to do so. My desire is to try to lock a small group of experts in a room and not let them out until they answer the burning questions!

INTERNATIONAL AFFAIRS

For both Phase-3B and the LEO satellite I have mentioned that we must not work in a vacuum -- these are international activities. We will be getting together to get our act together, but we must keep the rest of the world in mind. In that context, on 2-4 October we are having a small "summit" meeting of all the satellite construction groups in Paris. Represented will be the AMSAT-DL(West Germany), AMSAT-UK/Surrey, SA-AMSAT(South Africa), JAMSAT(Japan), MRASZ(Hungary), AMSAT-SM(Sweden), RACE(France) and possibly DOSAAF(USSR) groups. Jan King, Dick Daniels and I will be there to represent our interests. We plan to discuss inter-group coordination, launch opportunities, proposed new missions, frequency allocations, and myriad other technical details, but we are striving hard to be apolitical. On my list of topics are the packet activities described above in addition to several other possibilities. I will plan to to report to you on the outcome of the "summit" since it will clearly impact our thinking on digital and packet radio activities.

LOGISTICS

As I said above, I will be out of town until a day or two before the meeting, so I can't be of much help with transportation, accommodations, etc. You should feel free to call on Martha (AMSAT's office manager) at (301)589-6062 for any help. It might be an idea for you to confirm your attendance either by mail to me at my home QTH or by phone to Martha. We would like to know how many hamburgers and hot dogs to buy for the Sunday picnic too. Any of you who are bringing wives or POSLQ's or significant others might want to have them participate in the ad hoc tour of Baltimore's Harbor Place and the National Aquarium which my wife Elizabeth is organizing for Saturday. Please QSL to either Martha or to Elizabeth at (301)854-3113 if they are coming. I have made arrangements for accommodations for the TAPR delegation (Den and Lyle) but have had no other requests. We might be able to find a few of the locals who could put up people if you are working under constrained budgets. I understand that both the Sheridan and Ramada in New Carrolton are booked solid, But that the Holiday Inn on Route 1 in College Park and the Ramada in Calverton have rooms available. For those of you who have stayed at the Del Haven on Route 1 (a.k.a. the Roach Haven), I understand that their name has changed but that Martha knows how to get to them.

Hope this gives you enough material to chew upon before the meeting, and that you all will be able to attend. Keep in touch.

Vy 73,

Tom

Tom Clark, W3IWI

encl: KD2S Proposed Agenda
KD2S Bibliography
PACSAT Paper by DeRosa, Ozarow & Weiner
Distribution list

PACKET MEETING LIST de W3IWI 25 September 82

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Proposed Agenda for AMSAT Packet Meeting de KD2S
October 8 & 9, 1982

I. Systems

- A. Mode B / phase IIIB
  AMICON - L1
- B. Mode L / phase IIIB
  packet experiments
- C. Mode P / AMSAT-PACSAT

II. Physical Signaling

- A. Path Calculations & Power Requirements

- B. Modulation Techniques
  1. BPSK/DPSK/QPSK
  2. MSK
  3. FSK/AFSK

- C. Channel Access
  1. Aloha
  2. SATNET
  3. PACSAT
  4. other

III. Link Protocol

- A. Link Access
  1. Ethernet
  2. IEEE-802
  3. X.25 - LAPB
  4. other

- B. Link Management

- C. Link Addressing

IV. Network Protocol

- A. Internet Protocol
  1. NBS
  2. ARPANET

- B. X.25 Bridges

- C. other gateways/bridges

V. Hardware/Software Realizations

- A. satellite systems

- B. ground systems

VI. Task Apportionment

Bibliography for AMSAT Packet Radio Conference
October 8 & 9, 1982
de KD2S

I Systems

--general references--

" An Introduction to Packet Radio" by TAPR staff, 1982 (avail. on request)

" A Tutorial on Protocols" by Louis Pouzin & Hubert Zimmermann Procs. IEEE,66,#11,November 1978,pp1346-70

"Issues in Packet-Network Interconnection" by Vinton Cerf & Peter T. Kirstein,Procs. IEEE,66,#11,November 1978,pp1386-409

"General Purpose Packet Satellite Networks" by I.M. Jacobs, R. Binder & E.V. Hoversten,ibid.,pp1448-96

"An Introduction to Local Area Networks" by D.D. Clark, K.T. Pogram & D.P. Reed,ibid.,1497-517

--I A.. modeB/phase IIIB--

"AMICON System Specification, draft rev. 1.02" by H.S. Magnuski et al., October 1981

"Phase IIIB Special Service Channel Coordination Plan" by K1HTV & W4OWA, rev. draft 4/15/82

"Utilization of the Phase IIIB Special Service Channels" by R. Zwirko & Bob Ruedisueli, Orbit,March/April 1982,pp4-7

--I B.. modeL/Phase IIIB--
--I C.. Mode "P" ... no unique references--

==

II Physical Signalling

--general references--

see Jacobs, et al. above. Also

" Efficient Packet Satellite Communications" by J.K. DeRosa,L.H. Ozarow and L.N. Weiner,IEEE Trans. COMM.COM-27,#10,October 1979,pp1416-22

--II A.. path calculations--

"Satellite Design Sparks Debate" by Craig Covault, Av. Week & Space Tech., July 10, 1978,pp14

also refer to Jan King for details

--II B.. modulation techniques--

" A Comparison of Modulation Techniques for Digital Radio" by J.D. Oetting, IEEE Trans. Comm.,COM-27,#12,December 1979,pp1752-62

" Coherent Demodulation of Frequency-Shift Keying with Low Deviation Ratio" by Rudi DeBuda,IEEE Trans. Comm.,June 1972,pp429-35

"About Optimal Properties of Fast Frequency-Shift Keying" by R. DeBuda, IEEE Trans. Comm.,October 1974,pp1726-7

" MSK and Offset QPSK Modulation" by S.A. Gronemeyer & A.L. McBride,IEEE Trans. Comm.,COM-24,#8,August 1976,pp809-20

" The Viterbi Algorithm" by G.D. Forney, Proc. IEEE,61,#3,March 1973,pp268-78

"Spread Spectrum for Amateur Radio" by W.E. Sabin, Rockwell-Collins, Cedar Rapids, 1982

"Advances in Packet Radio Technology" by R.E. Kahn, S.A. Gronemeyer,J.Burchfiel & R.C. Kunzelman, Proc. IEEE,66,#11,November 1978,pp1468-96

" Designing Wide Tracking Phase-Locked Loop Systems" , Exar Integrated Systems Inc., Application Note AN-18, January 1981

--II C.. Channel Access--

see paper by DeRosa et al. for PACSAT description

see paper by Jacobs et al. for SATNET description

==

III. Link Level Protocol

see paper by Pouzin & Zimmermann

see IEEE Project 802 Local Network Standards, Draft C, May 17,1982

--III A.. link access--

"LSI Packet Network Interface WD2501/11 Short Form Data Sheet" by Western Digital Corp., June 1981

"Level 2 Protocol Proposal" by Terry Fox, AMRAD newsletter, April 1982

" TAPR Protocol" by Chuck Green in Tucson Amateur Packet Radio Activites Column, AMRAD newsletter, March 1982

--III B.. link management--

" Satellite Packet Communication - Multiple Access Protocols and Performance" by S.S. Lam, IEEE Trans. Comm.,COM-27,#10,October 1979

--III C.. link adressing--

see papers above on general protocol issues

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IV Network Levels

" Draft Report - Features of Internetwork Protocol", NBS Report No. ICST/HLNP-80-8, July 1980

==

V Hardware Realizations

see articles on modulation schemes above, also

" Phase Coherency in Tracking and Data Relay Satellites" by R.M. Gagliardi,IEEE Trans. Comm.,COM-27,#10,October 1979

A TAPR internal report has also been generated by Lyle Johnson on requirements for satellite and ground links for amateur radio, available on request from KD2S or WA7GXD.

Two other excellent general texts are available, which cover a large portion of all topics to be discussed:

" Computer Networks" by Andrew Tanenbaum,1981, Prentice-Hall

" Digital Communications by Satellite" by James J. Spilker, 1977, Prentice-Hall

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--24 September 1982 Den Connors KD2S--
--Minor editing by W3IWI 25 Sept--

Efficient Packet Satellite Communications

JOSEPH K. DeROSA, MEMBER, IEEE, LAWRENCE H. OZAROW, AND LESLIE N. WEINER

Abstract—**This paper gives an extensive analysis of a packet satellite (PACSAT) communications system that uses a digital processing satellite in a packet data network. It is shown that multiple uplinks coupled with on-board switching and storage can provide significant gains in throughput, efficiency, and margin against instability. Design tradeoffs are presented and the theoretical results are verified by extensive computer simulations.**

I. INTRODUCTION

A Packet Satellite (PACSAT) communications system is described in which a digital processing satellite acts as a central switching and storage node in a packet data network. When the usual transponding satellite is utilized as a network node, a large percentage of packets is lost through contention on the uplink. For example, in a synchronous random access (slotted ALOHA) configuration, a transponder fills the downlink with packets less than 37 percent of the time [1], [2].

However, DeRosa and Ozarow have recently pointed out that with a processing satellite there is no such fundamental limitation to the efficiency and throughput of a PACSAT system [3]. It was shown that the power-intensive downlink can be more fully utilized. This conserves weight and power in the spacecraft at the cost of additional uplink bandwidth and processing.

This paper gives an extensive analysis of a PACSAT system with on-board storage as well as multiple uplinks. Section II discusses the system configuration, traffic model and fundamental assumptions. Throughput, efficiency, and delay are carefully defined as the important system parameters and are related to the assumptions.

In Section III, performance calculations are made for two important queueing strategies: the first-in-first-out buffer and the read/write buffer. The blocked packets cleared strategy (i.e., no queue present) given in [3] is a special case of the former. The stable state results presented are verified by extensive computer simulations.

II. PACSAT SYSTEM

A processing satellite achieves data collection through its uplink multiple access scheme and data dissemination through its downlink broadcast. The PACSAT system achieves connectivity (via satellite communications RF links) with a large number of ground terminals which are themselves embedded in a packet data network. It is assumed that the satellite antennas are earth coverage and that the ground terminals operate in a full-duplex mode. The connectivity diagram is shown in Fig. 1.

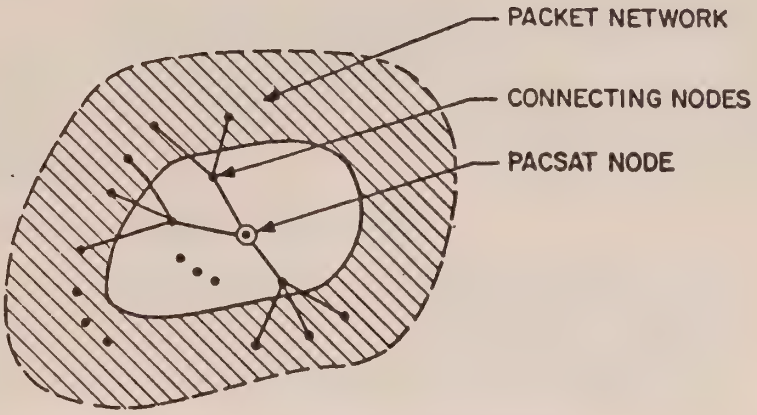

Fig. 1 PACSAT connectivity diagram.

The processing satellite demodulates these incoming packets, stores and switches the information at digital baseband, and remodulates the packets onto a TDM downlink broadcast. This is done under the control of an on-board microcomputer. A typical configuration with FDMA uplinks and a TDM downlink is shown in Fig. 2a, and a detailed discussion of a processing satellite configured this way is given in [4]. It is assumed that the communications links are perfect in the sense that the bit-error rate (in the absence of contentions) is zero. Therefore, the satellite may be viewed as a multiple access broadcast node as shown in Fig. 2b.

A. Slotted ALOHA Operation

The operation of PACSAT in a slotted ALOHA mode is shown diagramatically in Fig. 3. A user transmits a packet of length T seconds in one of n uplinks chosen at random. Each of the connecting nodes uses this same method to access the satellite. If a packet is successfully received on the uplink (i.e., if there is no contention), it may be switched into on-board storage. However, if there is contention on the uplink, the packets that collide are discarded at this point and consume none of the downlink power resources. (A simple parity check scheme is used to detect which packets are not destroyed by collisions.)

A packet may also be discarded if there is no more room for it in the on-board storage facility. Increasing the size of storage helps eliminate the discarding of valid packets. This increases the percentage of the downlink that is filled at a cost

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L. H. Ozarow was with M.I.T. Lincoln Laboratory, Lexington, MA 02173. He is now with Bell Laboratories, Murray Hill, NJ 07974.

L. N. Weiner is with M.I.T. Lincoln Laboratory, Lexington, MA 02173.

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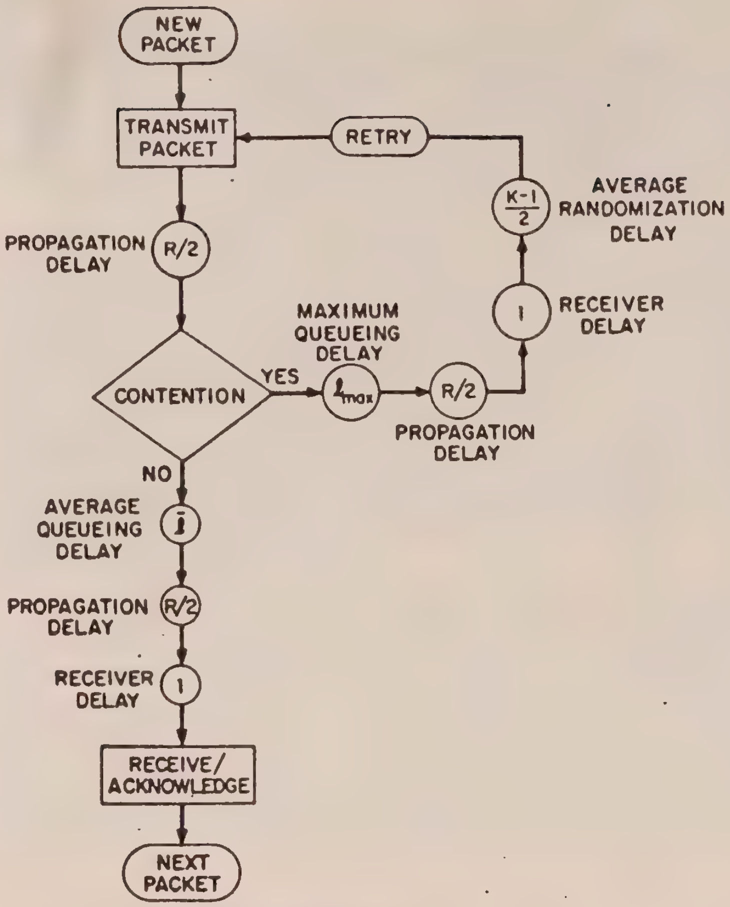
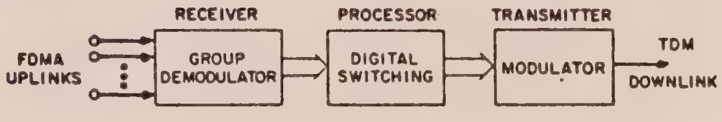
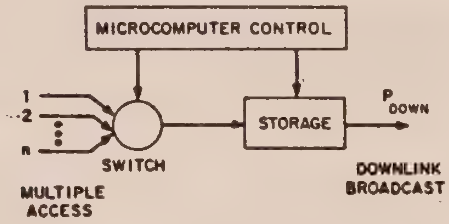


Fig. 2 The PACSAT system node.



(a) WITH n FDMA UPLINKS AND TDM DOWNLINK



(b) AS A MULTIPLE ACCESS BROADCAST NODE

Fig. 3 Packet transmissions.

of more power for the memory and therefore represents an important design tradeoff.

The stored packets are assembled into a TDM downlink and broadcast to the ground. Note that the uplinks and downlink are not totally independent. If the uplinks have insufficient capacity, the downlink will be starved for packets. Likewise if the uplinks are oversized, the packets will be blocked at the storage queue.

When a packet is transmitted on the downlink, it not only serves as a data source to the intended receiver, but also as an automatic acknowledgment to the sender. If the sender does not receive the packet within a standard acknowledgment time, T_A, retransmission is randomly placed into one of the n uplink channels during the next K time slots. With nK uplink (UL) slots from which to choose, the probability of repeated contentions is decreased. The acknowledgment time can be expressed (in packet time slots) as

$$T_A = R + l_{max} + 1 \tag{1}$$

where

R = round trip propagation delay from beginning of transmission to end of reception
l_{max} = maximum on-board storage delay

and an extra time slot is needed to account for reception of the packet.

B. System Parameters and Assumptions

The fundamental system parameters that are used in performance evaluation are packet throughput, power efficiency and packet delay. Throughput S is defined as the average fraction of the downlink (DL) time slots that contain packets, i.e.,

$$S \triangleq E\{\text{number of packets per DL slot}\}.$$

Since each downlink slot can contain only 0 or 1 packet, throughput can be evaluated by

$$S = 0(1 - P_{down}) + 1 \cdot P_{down} = P_{down} \tag{2}$$

where

$$P_{down} \triangleq \Pr\{\text{a packet is successful on UL and DL}\}.$$

Efficiency η is defined as the average downlink data rate R per unit of spacecraft power P allocated to the communications subsystem, i.e.,

$$\eta \triangleq \frac{R}{P} \text{ bits/s/W}. \tag{3}$$

R and P are given by

$$R = R_b S \text{ bits/s} \tag{4}$$

$$P = P_1 + \frac{1}{\alpha} P_T \text{ W} \tag{5}$$

where

R_b = downlink burst rate
P_T = transmitted power
α = efficiency with which bus power is converted to P_T
P_1 = all other power (e.g., demod/remod, switching, L. O.'s, etc.).

Therefore, the efficiency can be written as

$$\eta = \frac{R_b S}{P_1 + P_T/\alpha}. \tag{6}$$

In order to maintain a constant ratio of energy per bit to noise power density (E_b/N_0) at the receiver terminals, the

ratio P_T/R_b must remain constant. Therefore, efficiency increases when uplinks are added as long as the percentage change in throughput is larger than the normalized percentage change in the power required to service the uplinks. When $P_T \gg P_1$, efficiency varies almost linearly with throughput.

Before defining delay, it should be noted that the systems described can remain at their normal operating point only for finite time (i.e., they are quasi-stable). Short-term fluctuations in the number of packet births or gradual change in the average packet load will eventually drive the system to saturation; that is, with probability one, a large number of new packet arrivals will eventually occur in a short time, driving the system into an overload from which it cannot recover. This phenomenon and a finite source alternate traffic model which deals with it are discussed in [7].

In order for the system to be operating at a quasi-stable equilibrium point, the statistics of the process must change much more slowly than the time it takes for a packet to be successfully communicated. The simulations presented in Section III have shown that the system remains quasi-stable for considerably long times (at least 50,000-packet time slots) when it is not operated near saturation. When this is the case, the throughput is equal to the new packet generation rate,

$$S = \lambda T_p \text{ packets/time slot} \tag{7}$$

where

λ = new packet arrival rate (packets/second)

T_p = duration of time slot (seconds).

It is assumed that the new packets are generated according to a Poisson random process.

However, not all the packets being transmitted are new ones; some are retries. The total average number of packets in the system at any given time is then

$$\overline{N} = G \cdot \frac{T_A}{T_p} \tag{8}$$

where the acknowledgment time T_A is now measured in seconds and

$$G \triangleq E\{\text{number of total packets generated per time slot}\}.$$

The average packet delay D is defined as the average time that it takes to successfully communicate a packet. This is evaluated from

$$D = (\bar{r} + 1)\, T_A \tag{9}$$

where

$$\bar{r} \triangleq E\{\text{number of retries}\}.$$

From Little's result [5] it is known that

$$\overline{N} = \lambda D. \tag{10}$$

Substituting (7)-(9) into (10) gives

$$G = S(\bar{r} + 1). \tag{11}$$

The average delay (in number of time slots) from the transmission of a packet to the successful reception (see Fig. 3) is given by

$$\begin{aligned} D &= \sum_{r=0}^{\infty} \left[R + 1 + \bar{l} + r\left(R + 1 + l_{\max} + \frac{K-1}{2} \right) \right] Q_r \\ &= (R + 1 + \bar{l}) + \bar{r}\left(R + 1 + l_{\max} + \frac{K-1}{2} \right) \end{aligned} \tag{12}$$

where

$\bar{l}$ = average queueing delay in the satellite

$l_{\max}$ = maximum queueing delay in the satellite

Q_r = Pr {successful transmission after r retries}

R = round trip delay.

The term $(R + 1 + \bar{l})$ accounts for the average delay when the first try is successful and the other term accounts for the average delay when retries are necessary. Note that before attempting a retry, the user must wait the propagation delay R, the receiver delay of 1 time slot, the maximum queueing delay $l_{\max}$ and an average randomization time $(K-1)/2$.

Under the assumption that the probability of successful transmission is the same on any try,[*] r has a geometric distribution, i.e.,

$$Q_r = q(1-q)^r \tag{13}$$

where

$q \triangleq P_r${a given packet is successful on uplink and downlink}

and

$$\bar{r} = q \sum_{r=0}^{\infty} r(1-q)^r = \frac{1-q}{q}. \tag{14}$$

Substituting (14) into (11) gives

$$q = S/G. \tag{15}$$

III. PERFORMANCE

The performance of PACSAT measured in terms of throughput, delay and efficiency depends on the particular queue discipline that is used in the satellite processor. Here we will evaluate two types of queues that are particularly convenient for hardware implementation: the first-in-first-out (FIFO) and the read/write buffers. Theory and numerical evaluations are presented with extensive computer simulations to verify the practical application of results. In all of the numerical

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[*] Our simulations have shown this to be a reasonable assumption for K sufficiently large. See also [2] and [6].

results presented below, ARPANET/INTELSAT parameter values have been used (e.g., 50 kbit/s channels, 1 kbit packets, 0.24 s round-trip delay). This gives a round-trip delay of $R = 12$ packets; a randomization interval of $K = 15$ has been arbitrarily assumed.

A. The FIFO Buffer

The FIFO Buffer can store a queue of up to L packets. Packets that successfully arrive on the uplinks (i.e., without contention) are placed at the end of the queue and the oldest queue member is read out during each packet time interval. No preference is shown to packets that arrive simultaneously. When the buffer is filled, even successful packets are discarded, and when the buffer is empty, the downlink contains no data.

We assume that the queue occupancy transitions are Markov. Therefore,

$$q^{t+1} = q^t M \tag{16}$$

where q^t is the queue occupancy probability row vector at time t and $M = [m_{ij}]$ is the queue occupancy transition matrix

$$m_{ij} = \Pr\{j \text{ packets in queue at time } t + 1 \mid i \text{ at time } t\}. \tag{17}$$

Therefore, the steady state occupancy vector must satisfy

$$\pi = \pi M \tag{18}$$

where

$$\pi = [\pi_0, \pi_1 \cdots \pi_L] \tag{19}$$

and

$$\pi_i = \Pr\{i \text{ packets in queue in steady state}\}. \tag{20}$$

To solve Eq. (18) uniquely for π, one must use the obvious fact that

$$\sum_{i=0}^{L} \pi_i = 1. \tag{21}$$

Within any given time slot, if the packet arrivals in different UL channels are assumed independent, the total number of successful arrivals in the n uplinks follows a binomial probability law

$$p_j \triangleq \Pr\{j \text{ successful arrivals in a time slot}\} = \binom{n}{j} p_s^j (1 - p_s)^{n-j} \tag{22}$$

where p_s is the probability of one uplink success, i.e.,

$$p_s = \frac{G}{n} e^{-G/n}. \tag{23}$$

The $\{m_{ij}\}$can be computed from Eq. (22) by noting the following:

(1) No more than one packet leaves the queue in any time interval.

(2) The transition from 0 packets to 0 packets occurs when there are either no arrivals or one arrival (because there is always one departure).

(3) Any number of arrivals between $L - i + 1$ and n will fill up the queue.

(4) Otherwise, $j - i + 1$ arrivals are needed to go from i packets in queue to j packets in queue.

Therefore,

$$m_{ij} = \begin{cases} 0 & j < i - 1 \\ p_0 + p_1 & i = j = 0 \\ \displaystyle\sum_{k=L-i+1}^{n} p_k & j = L \\ p_{j-i+1} & \text{otherwise.} \end{cases} \tag{24}$$

To compute throughput $S = P_{\text{down}}$, we note that in any given time slot no packet is sent down when the queue is empty and there is no successful arrival, i.e., $1 - P_{\text{down}} = \pi_0 p_0$. Therefore, from Eq. (2)

$$S = 1 - \pi_0 p_0. \tag{25}$$

In order to compute delay from Eq. (12), we need

$$l_{\max} = L \tag{26}$$

$$\bar{l} = \sum_{i=0}^{L} i\pi_i. \tag{26'}$$

Note that for any total traffic load G, S can be computed from Eq. (25) and q from Eq. (15). These are then substituted into Eq. (12) to get delay. When $L = 0$ is the queue length, only one packet at most can be successful in any given time slot, and the others must be blocked and cleared (i.e., discarded because there is no storage). Closed form expressions for the throughput and delay in the blocked packets cleared case were previously derived by the authors [3]. The results are shown in Figs. 4 and 5 with computer simulations superimposed and for later comparisons with other schemes.

There are several important features of the curves that should be noted before proceeding any further:

(1) When $n = 1$ is the number of uplinks, PACSAT gives the same performance as a standard repeating satellite.

(2) n need not be very large before substantial gains in throughput are obtained with the same downlink power consumption as in the repeater.

(3) Since the system becomes unstable (i.e., the delay becomes infinite) near maximum throughput, the addition of more uplinks provides increased margin against instability at any given throughput.

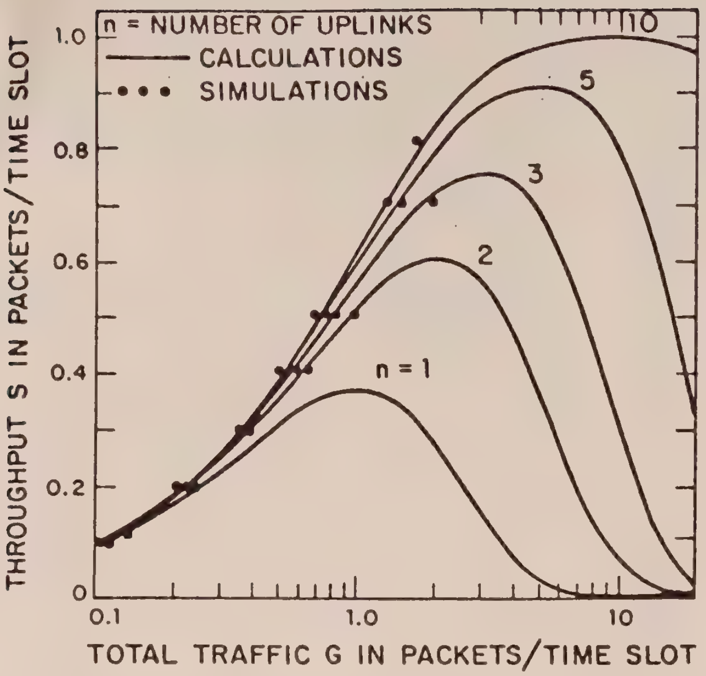

Fig. 4 Throughput for slotted ALOHA with blocked packets cleared (queue length $L = 0$).

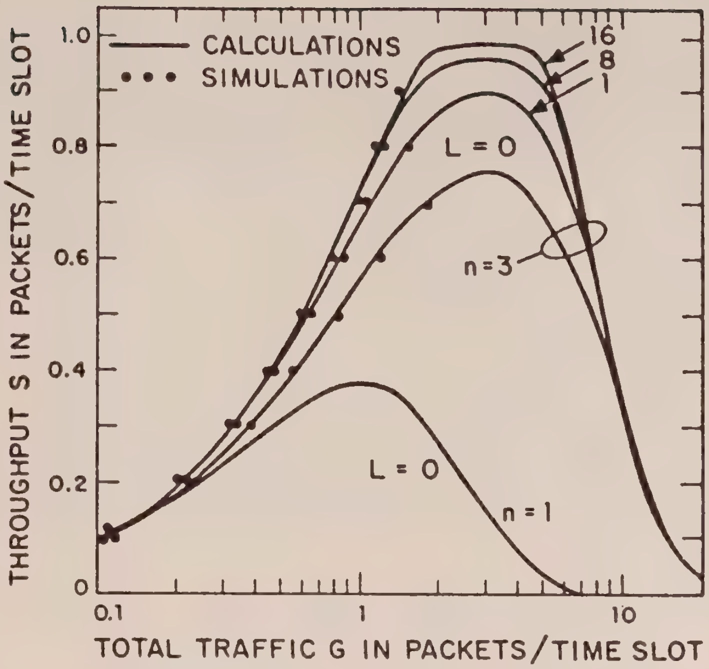

Fig. 6 Throughput for slotted ALOHA with FIFO buffer of length L packets.

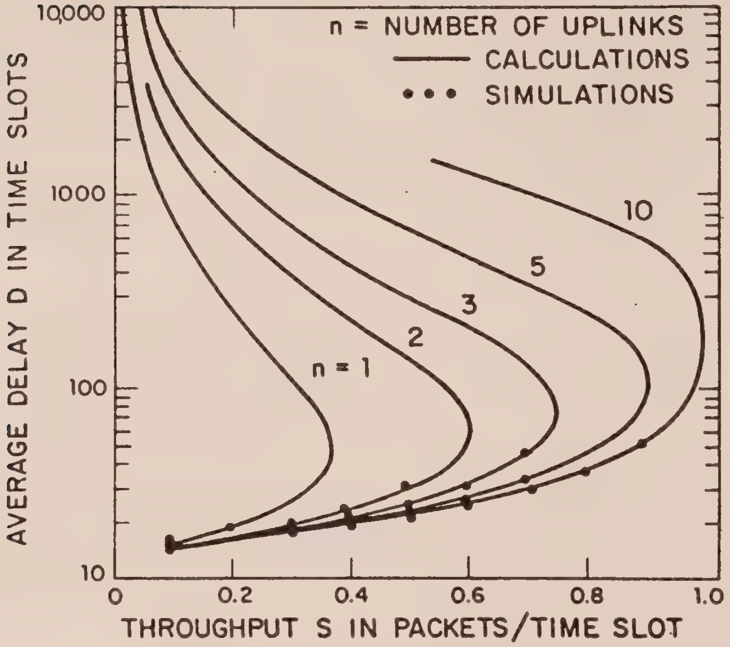

Fig. 5 Delay for slotted ALOHA with blocked packets cleared (queue length $L = 0$).

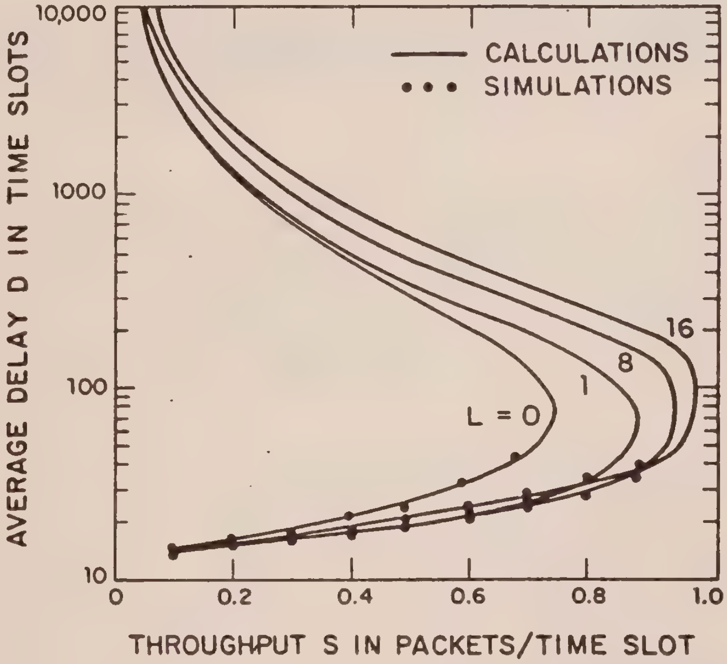

Fig. 7 Delay for slotted ALOHA with FIFO buffer of length L packets.

Simply stated, PACSAT has the advantages of increased throughput and margin against instability at the costs of additional uplink channels (bandwidth) and satellite prime power for digital processing.

When the uplink bandwidth becomes limited, these same advantages can be realized by adding a FIFO buffer in the satellite. This is shown in Figs. 6 and 7 for a system limited to $n = 3$ uplinks. Note that a marked increase in throughput is achieved for a queue length as small as $L = 1$, and moreover, for $L = 16$, nearly 100 percent throughput is obtained. It is also interesting to note that the $L = 16$ curve tends to flatten out near the maximum. Thus, near-maximum throughput can be achieved at traffic levels that do not yet drive the system into the unstable state.

From Fig. 7 it is seen that adding the FIFO buffer has the same effect on delay and therefore stability as did adding more uplinks in the case of blocked packets cleared. All of the theoretical results are quite well verified by the simulation points shown in Figs. 4 through 7.

B. Read/Write Buffer

The Read/Write Buffer consists of two random access memories of length K packets. Packets that successfully arrive within K time slots are placed in the Write buffer when the Read buffer is feeding the downlink. At the end of K time slots (i.e., a frame), the Read and Write buffers are interchanged and the process repeats itself. As in the FIFO case, no preference is shown to packets that arrive simultaneously and

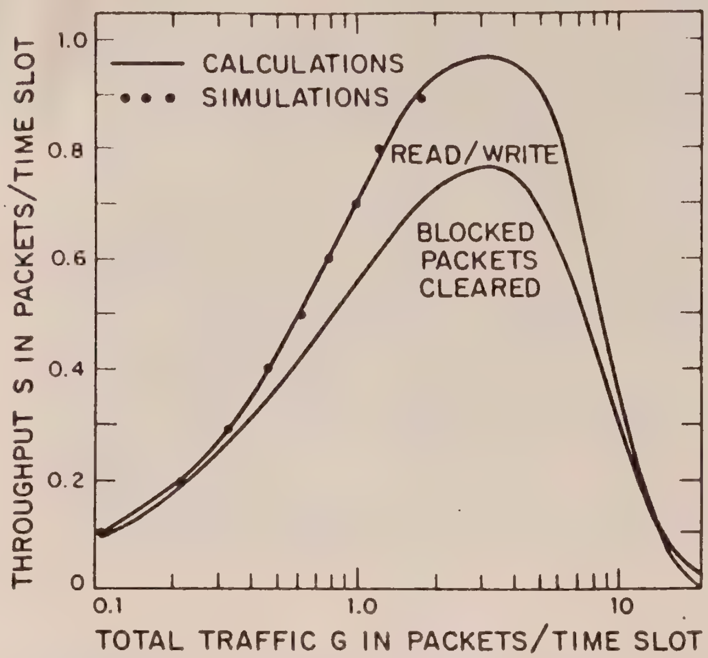

Fig. 8 Throughput for slotted ALOHA with read/write buffer of length 15 packets.

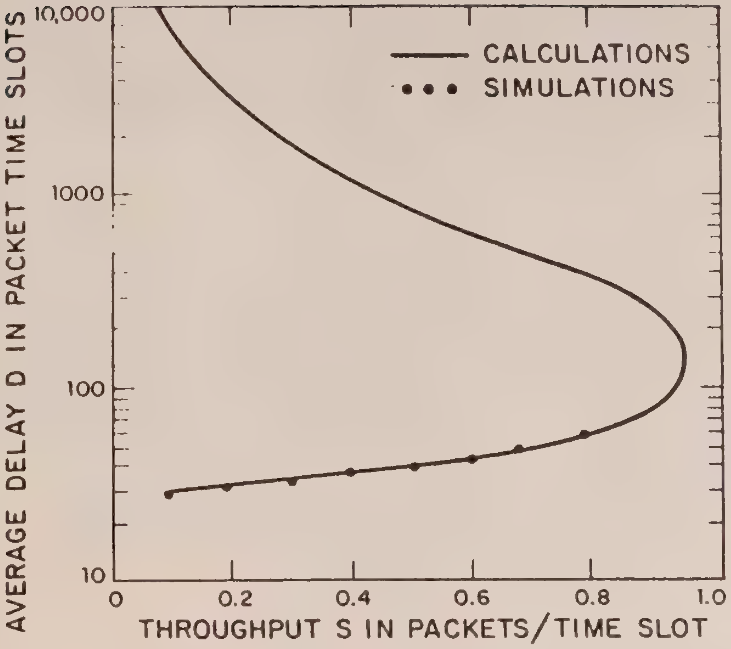

Fig. 9 Delay for slotted ALOHA with read/write buffer of length 15 packets.

when the Write buffer is filled, successful packets are discarded.

If packet arrivals in different UL channels and different time slots are assumed independent, the total number of successful arrivals in a frame of length K packets follows a binomial probability law with

$$\begin{aligned} p_j &= \Pr\{j \text{ successful arrivals in a frame}\} \\ &= \binom{nK}{j} p_s^j (1-p_s)^{nK-j} \qquad (27) \end{aligned}$$

where p_s is given by Eq. (23). When there are j successful arrivals, the number of packets sent down in the next frame is $\min(j, K)$; therefore,

$$\begin{aligned} &E\{\text{number packets per DL frame}\} \\ &= \sum_{j=0}^{nK} \min(j,K)\, p_j \\ &= K - \sum_{j=0}^{K} (K-j)p_j. \qquad (28) \end{aligned}$$

The average number of packets per DL slot is then $1/K$ times this amount, and from (2) the throughput is

$$S = 1 - \sum_{j=0}^{K} \left(1 - \frac{j}{K}\right) p_j. \qquad (29)$$

When K packets enter the write buffer at the beginning of the read cycle, then the last packet is delayed $2K$ time slots before it is read out. Therefore,

$$l_{\max} = 2K. \qquad (30)$$

Placing the packets uniformly in the Write buffer yields an average write-cycle delay of $K/2$. The average read-cycle delay is $K/2$. Therefore,

$$\bar{l} = K. \qquad (31)$$

The throughput and delay for the case when a read/write buffer is used are shown in Figs. 8 and 9. The results are quite similar to those obtained with the FIFO buffer. Thus either scheme can be used to obtain the performance gains that were discussed in connection with the FIFO.

C. Conclusions

A packet satellite system that has on-board demodulation/remodulation can provide significant increases in throughput and more efficient utilization of the limited downlink power resources. This is accomplished with additional uplinks that decrease random access contentions and with on-board storage that provides a buffered source of packets for the downlink.

This paper has developed the theory of packet switching in a digital processing satellite. Numerical examples are given for a typical network configuration and two convenient hardware implementations of the on-board storage. Extensive computer simulations have been used to verify the theory and demonstrate the significant improvements in performance.

However, the significance of this work is not so much in the quantitative results as it is in their fundamental nature, i.e., a satellite can be efficiently utilized in a packet data network. Several design options and bandwidth/storage trade-offs have been indicated, but additional configurations are obviously possible: priority schemes, higher burst rate uplinks, multiple downlinks, integrated voice and data, integrated circuit and packet switching to name a few.

ACKNOWLEDGMENT

The authors would like to thank Chi-Hwa Tai for his programming assistance.

REFERENCES

1. N. Abramson, "Packet switching with satellites," *Proc. National Computer Conf.* (June 1973), pp. 695-702.
2. L. Kleinrock and S. Lam, "Packet-switching in a slotted satellite channel," *Proc. National Computer Conf.* (June 1973), pp. 703-710.
3. J. K. DeRosa and L. H. Ozarow, "Packet Switching in a Processing Satellite," *Proc. of IEEE,* Vol. 66, No. 1 (January 1978), pp. 100-102.
4. J. K. DeRosa, "A Digital Processing Satellite for Widely Disseminated Telecommunications," *Telecomm. and Economic Develop–INTELCOM 77,* Horizon House Int. (October 1977), pp. 307-311.
5. L. Kleinrock, *Queuing Systems, Vol. II, Computer Applications* (John Wiley & Sons, New York, 1976).
6. L. G. Roberts, "Optimal retransmission delay for ALOHA system," ARPANET Satellite System Note 9, NIC #11291 (July 3, 1972).
7. L. Kleinrock and S. Lam, "Packet Switching in a Multiaccess Broadcast Channel, Performance Evaluation," *IEEE Trans. on Comm.,* COM-23, 4, 5, pp. 410-423.

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★

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Since 1974 she has been with M.I.T. Lincoln Laboratory working in the area of satellite communications.

DR. THOMAS A. CLARK
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News Release on Packet Radio Activities
de AMSAT 16 October 82

*** Long-haul Packet Test Successful ***

. . . . . .

On 16 October 1982, from 16:45 UT until 17:00 UT, a successful long-haul Packet Radio demonstration QSO took place between Maryland and Texas; the stations involved were Bob Diersing, N5AHD in Corpus Christi and Tom Clark, W3IWI near Washington. The QSO took place on the 10 meter band at 28.300 kHz with both stations running FSK at a 1200 baud rate using HDLC protocol currently accepted as amateur radio standards.

. . . . . .

This demonstration represents another phase of the AMSAT activities to advance the state-of-the-art in amateur radio communications technology development and the tests were conducted to test the suitability of various existing hardware and protocols under weak-signal and QRM conditions in anticipation of the AMSAT Phase-3B satellite launch in February, 1983, and to help in the planning of future satellite missions including a possible dedicated packet radio mission a few years from now.

. . . . . .

The demonstration QSO took place just one week after a landmark meeting held under AMSAT's auspices to establish and coordinate common packet radio protocols. This meeting in the Washington,DC area was attended by representatives of packet radio groups from San Francisco, Tucson, St. Louis, Washington and New Jersey. The meeting succeeded in reconciling minor differences that had evolved between the various groups during their R&D activities. The goal of establishing common protocols was focused on the upcoming satellite launches when it will be possible, for the first time, for the different packet radio groups to reliably inter-connect local networks on a global basis.

. . . . . .

During the long-haul test, both N5AHD and W3IWI were using special 8085 microprocessor-based Terminal Node Controller (TNC) hardware developed in Canada by the Vancouver Area Digital Group (VADG), equipped with software developed in Vancouver, San Francisco and Washington. They both used conventional "202A" FSK modems operating thru 100 watt SSB transceivers. A number of packets were successfully exchanged in both directions and the TNC board's software automatically verified the accuracy of each transmission. The HDLC protocol dictates that if any error is detected, the transmitting station re-tries until an error-free copy is received. In the test QSO, the number of re-tries required never exceeded three. The stations had conducted previous long-haul test experiments through the AMSAT-OSCAR-8 satellite.

. . . . . .

W3IWI has been involved in a number of previous AMSAT demonstration tests including initial feasibility demonstrations using the AMSAT-OSCAR-6 and -7 satellites which led to the international Search-and-Rescue Satellite (SARSAT) program to locate downed aircraft, and tests of digital phase-shift keying (PSK) techniques to be employed on the Phase 3 satellite series. N5AHD has developed automated, real time telemetry acquisition techniques for the UoSAT-OSCAR 9 satellite and operates AMSAT's Computer Bulletin Board System (CBBS) which can be accessed at (512)852-8194. Both N5AHD and W3IWI have been frequent contributors of amateur radio software which is available through the AMSAT Software Exchange (ASE). Further information about AMSAT, ASE or AMSAT's CBBS can be obtained by calling the CBBS or by writing:

AMSAT
Box 27
Washington, DC 20044

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Hank:

Fetched This from OnTyme & did some minor editorial work — Changes are ~~[illegible]~~ Hi-lighted in red.

I've asked DC to augment the PACSAT Section a bit if he wants

Speak now or forever hold your peace!

73,
Tom

P.S. Attached 2ND Release may be of some interest.

Special to AMSAT Satellite Report
de Hank Magnuski, KA6M 12 October 82
(minor editorial revisions de W3IWI)

AGREEMENT ON PACKET RADIO STANDARDS!

As part of the October 10th, 1982 AMSAT (Radio Amateur Satellite Corp.) general meeting, president Tom Clark, W3IWI, invited a number of leaders of active packet radio groups to come to a special working group meeting on Friday, October 8th, to discuss the future developments in packet radio activities; specifically, this meeting was intended to discuss AMICON (the AMSAT International Computer Network) for the Phase-3B spacecraft and to discuss a new project (tentatively called PACSAT) involving a low-altitude orbit, all digital store-and-forward transponder. To Tom's pleasure and surprise, the meeting was well supported and a number of people showed up, representing these groups:

New Jersey - Phil Karn, KA9Q;

Tucson Area Packet Radio (TAPR) - Den Connors, KD2S and Lyle Johnson, WA7GXD;

St. Louis Area Packet Radio (SLAPR) - Pete Eaton, WB9FLW;

Washington (AMRAD) - Paul Rinaldo, W4RI, Dave Borden, K8MMO, Terry Fox, WB4JFI and Eric Scace, K3NA;

Pacific Packet Radio Society (PPRS) - Hank Magnuski, KA6M;

AMSAT - Tom Clark, W3IWI, Jan King, W3GEY, John DuBois, W1HDX and Bob Carpenter, W3OTC.

Even more surprising is that this diverse group managed to agree on some things. In fact, the agreement reached on adopting a common link level protocol may prove to be extremely significant in forming the foundation for U.S. packet radio networking. The meeting which originally was supposed to iron out some AMICON details managed to have much more of an impact. Here's some background on what happened:

A year ago, in conjunction with the '81 AMSAT general meeting, Paul Rinaldo organized the first Packet Radio Networking Conference under the sponsorship of AMRAD, ARRL and AMSAT in Washington (some excellent conference proceedings are still available). Many ideas and some real and paper networks were discussed. In the months which followed quite a few people got their packet radio controllers running and had a chance to experiment, read, discuss and think about various problems involved in implementing packet radio networks. The situation became discouraging. It seemed like a new protocol was proposed for each new set of Terminal Node Conroller (TNC) hardware that came on the air. Each group started heading off in a somewhat different direction. The promise of compatible systems was growing remote. But in this dispersion of effort, people also found out how difficult it was to implement private protocols and how difficult the interconnection would be if common ground wasn't found soon. The different groups also came to realize that there were a common set of problems to be solved and that one area's solution couldn't ignore the requirements of other users. The summer doldrums saw very little activity and not much progress, and provided the background for the AMSAT meeting. This inevitable diversity during the R&D phases for each of the groups had to be reconciled with the impending launch of the Phase-3B satellite in February, 1983.

The AMICON Network

Three major areas of concern filled the agenda of the AMICON meeting: the usage of the Special Service Channel (SSC) earmarked for digital experimentation and called "AMICON" in AMSAT planning documents; the recommended modulation methods and bit rates to be used on the Phase-3B SSC; and the detailed link protocol to be used for linking ground stations via the satellite.

There was general agreement that standards accepted today must be regarded as developmental. It is to premature to ordain any single scheme at this time. The AMICON concept is not yet a detailed network design, but rather an opportunity to develop a new service for amateur radio. In the developmental phases we may well see many diverse techniques being tested. The meeting discussed the concept that the use of high-altitude satellites for packet radio would be sufficiently complex that it was unlikely that many individual users would be able to muster the resources for individual access. Rather, AMICON would probably evolve as a channel for linking local "concentrator" nodes around the world.

There was a lot of discussion on suitable modulation methods and bit rates that could be supported by Phase-3B. Den Connors and Lyle Johnson of TAPR, Paul Rinaldo of AMRAD, and Tom Clark and John DuBois of AMSAT presented their research findings. Many different modem types were reviewed and international requirements were discussed. After all the debate the following conclusions were reached:

1. The AMICON SSC usage should be restricted to 5 kHz bandwidth (at the -26 dB points). Modem performance must be a primary consideration for any ground station, and the modem used will probably be of a rather advanced design.

2. The use of 202-type modems using NBFM-AFSK will not work.

3. The use of 202 modems using SSB-FSK will produce marginal results.

4. A 400-1200 bps channel speed is probably optimal, as this speed satisfies a variety of different constraints and requirements.

5. The PSK modulation techniques developed for Phase-3B telemetry should be explored at both 400 and 1200 bps.

6. The AMRAD and TAPR groups are going to pursue development of a modem which employs Minimum Shift Keying (MSK). MSK and PSK are considered the most promising methods at this time.

7. The SSC will have to be open for different experimental approaches until there is general agreement and experimental validation of "the" optimum method.

Considering all the alternatives which were discarded, the above resolutions represent a significant narrowing of focus. If that wasn't enough, more was yet to come!

Eric Scace reviewed the work which had been done by the NJ & AMRAD packeteers to adapt the international X.25 protocol to amateur needs. The amateur subset has been documented by Terry Fox, and is now called AX.25. Hank Magnuski distributed a tutorial document on connectionless protocols and described work which had been done to develop Revision 4

of the TIPM and LIPM software. This is the first implementation of TNC software utilizing only amateur calls (and not hard-wired assigned addresses) for addressing.

By the evening of the October 8, the group began to recognize that only very minor differences separated the AX.25 and LIPM.04/TIPM.04 approaches. The TAPR protocol users were willing to implement an interface based on the recommendations which would come out of the meeting. The differences were resolved and led to the unanimous adoption of a subset of an internationally recognized link level protocol (specifically it is called ANSI X3.66 ADCCP-HDLC BA Class, with options 2, 4, 7, 8, & 11).

Why is this important? First, this link level protocol allows two AMICON ground stations to construct a packet pipeline. This same protocol can be used between two stations in a terrestrial backbone net. The same protocol can also be used for terminal-to-terminal connections, whether direct or via a simplex packet repeater. It represents only a slight extension of the CCITT X.25 LAPB link level protocol. And finally, it does not restrict future development of ISO Level 3 virtual circuit or datagram protocols.

The key feature of the new design is the adoption of a scheme for using call-sign addressing in a packet. The packet format looks like this:

```
 -----------------------------------------------------------------------
 | FLAG1 | TOCALL | FMCALL | CTL | PID | INFOFIELD | FCS | FLAG2 |
 -----------------------------------------------------------------------
```

where:

FLAG1	Standard opening HDLC flag byte (01111110)
TOCALL	The destination call-sign (6 char's plus sub-station ID code)
FMCALL	The source call-sign of (6 char's plus sub-station ID code)
CTL	Standard HDLC control byte
PID	Protocol Identification byte for information frames.
INFO	Information field in information frames
FCS	Frame CRC check sequence
FLAG2	Standard closing HDLC flag byte

Frames to be repeated by a local area network simplex packet repeater also contain a third address field following the FMCALL field. This third field is the callsign of the repeater. More details on this protocol will be published in the revised AX.25 specificiation document by WB4JFI et al.

Collectively, the group considered that nearly every link design starts out with a statement something like this: "Holy 807's, look at all the overhead bytes you have in using call signs as addresses. I can do it with just 4 bits." We have found that these other schemes have their own defects and that the penalty for the call sign overhead is relatively small in comparison to other delays on the link and in view of the other benefits. In addition, both amateurs and their regulatory authorities are particularly defensive that the call sign is sacrosanct and tantamount to a personal name.

The AMICON session ended with promises from various representatives to try to implement the required versions of this new protocol. In the interim, LIPM.04/TIPM.04 will be available for use by AMICON ground stations until the new software is ready.

PACSAT

Tom Clark described a potential opportunity in the late '84 time-frame for a new low-altitude orbital launch. Tom reviewed various considerations which led to the concept of building a satellite which could be an all digital store-and-forward transponder -- in other words, a flying mailbox. This satellite would have a computer, two or more digital serial I/O channels, appropriate modems, and 1/2 to 1 megabytes of on-board message storage memory which could be treated as a "virtual disk". Messages put in on one side of the earth could be extracted on the other side. The operation would be somewhat like using a landline bulletin board system, but with the satellite available for a few 15 minute passes each day.

Tom presented a strawman preliminary design, and there was an extended discussion of the pro's and con's of the project, the ways it might be implemented and the ways it could be used. Considerable discussion on the relative volume of up- and down-link data, models on which to base loading calculations, desired bit rates and feasible modem standards ensued. Tom also discussed the international involvement in this project, indicating the major roles that the UK and South Africa are likely to have. Den Connors and Lyle Johnson agreed to put together a more detailed PACSAT proposal for Saturday, and presented it at a seminar on the morning of the 10th. Den has agreed to act as interim PACSAT coordinator and we can anticipate considerable discussions on the design and concepts in the future.

The general PACSAT concept was presented at the AMSAT general meeting, and the AMSAT membership welcomed the idea, with the only caveats being "Can we afford it? Are we stretching ourselves too thin?" Tom indicated that these were AMSAT management concerns too but that the key individuals were very enthusiastic about the concept ... since no further opposition was raised, further development of the PACSAT concept is expected.

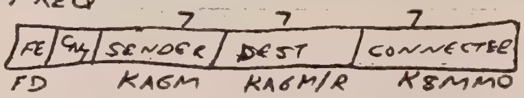
10 OCT82 kd2s

meeting of OCTOBER 8th

protocol comparisons

LIPM 04 (PPRS)

CONNECT REQ



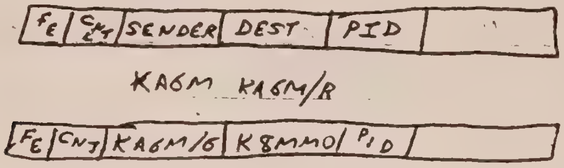
CONNECT ACK

~~KAGM~~ K8MMO K8MMO

DISC
DISC ACK

STATION CONNECT REJ
REPEATER " "

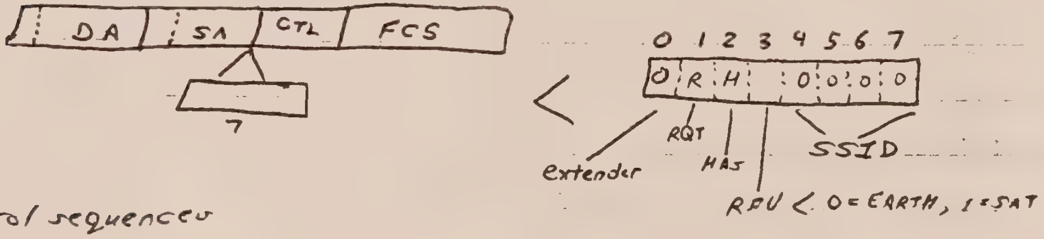
BROADCAST PACKET



K8MMO1

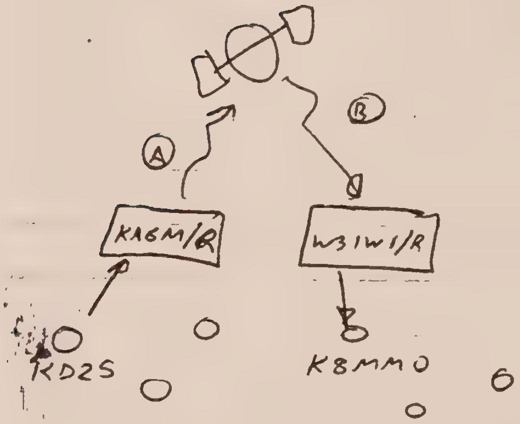
RR
RNR

AX.25

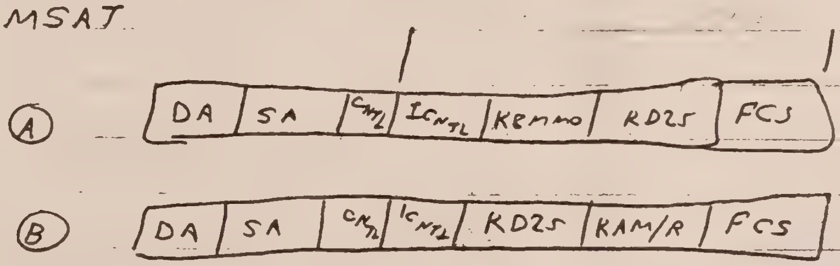


Control sequences

CTL= UA, DISC, UA, FRMR, UI, DM



AMSAT



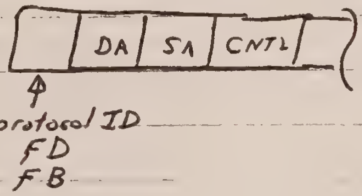
AMSAT AMICON TARGET

level 1 ALOHA 1200b/s MSK – recoomend?
2 LAPB – w/ addr mod – "
3 < datagram / virtual circuit } further study?

K3NA: 301-293-2448

CONNECTION ESTABLISHMENT

	DA	SA	C	
KD25 xmits:	KA6M/R	KD25	I (link setup)	info field contains: { calling party = KD25 called party = K8MMO ROUTING INFO { a) explicit: KA6M → W3IWI/R b) geographic ID c) unspecified
KA6M/R xmits:	a) W3IWI/R b) } group adx c) } CQCQCQ	KA6M/R	I	" " "
W3IWI/R xmits:	K8MMO	W3IWI/R	I	" (optionally deleted)



typical sequence

DA	SA	C	info
W3IWI	KA6M	SABM	
KA6M	W3IWI	UA	
W3IWI	KA6M	I	call req. KD25 → K8MMO
W3IWI	KA6M	I	call req. K3NA → WB4JFI
W3IWI	KA6M	I	call clear KD25 → K8MMO
K4XYZ	W3IWI	SABM	
W3IWI	K4XYZ	UA	
⋮			

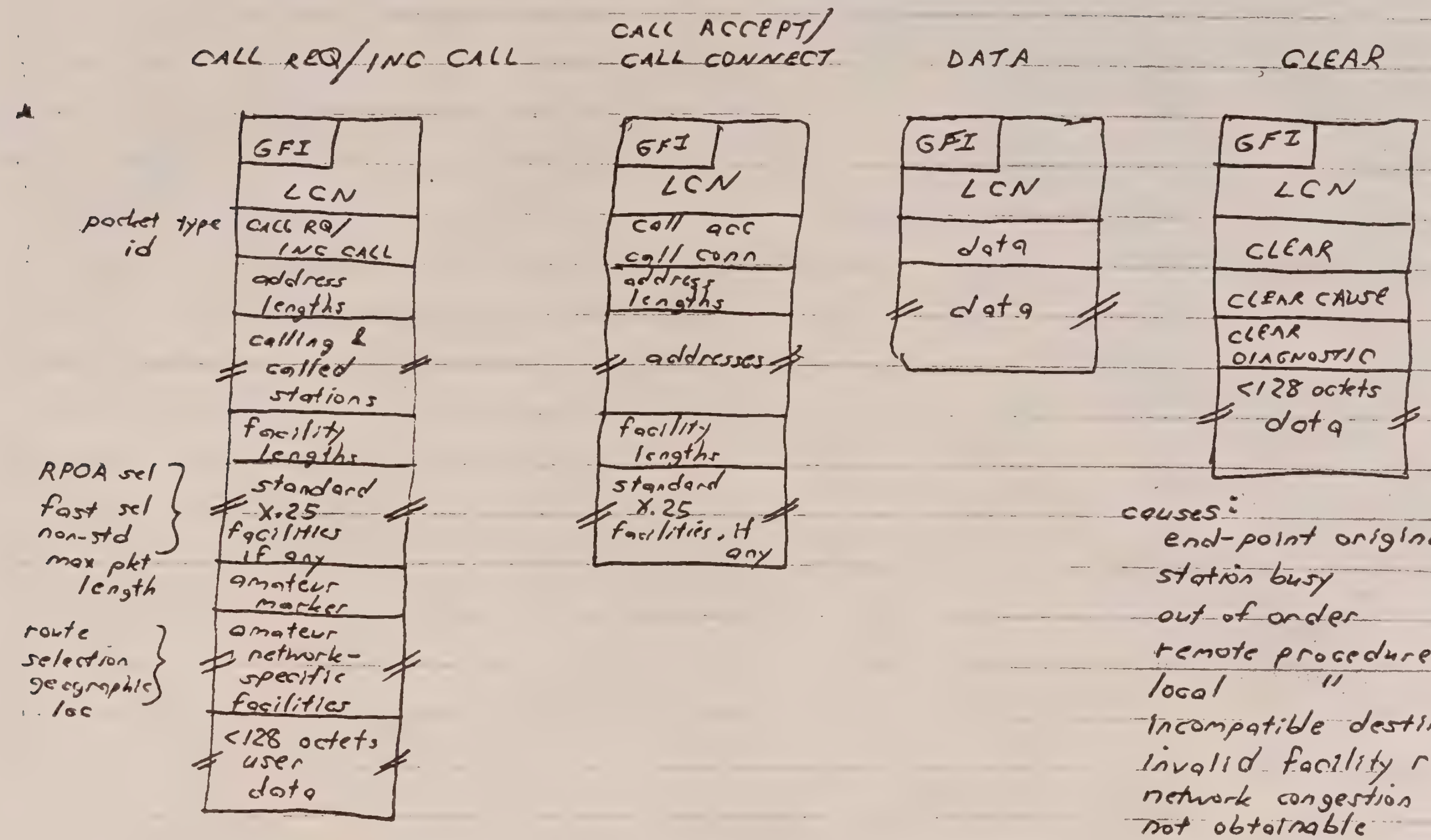
call req. / inc. call
call clearing (cause)
data
flow control (RR, RNR)
global restart
reset within a call

10 OCT 82 kd

meeting of OCTOBER 8th

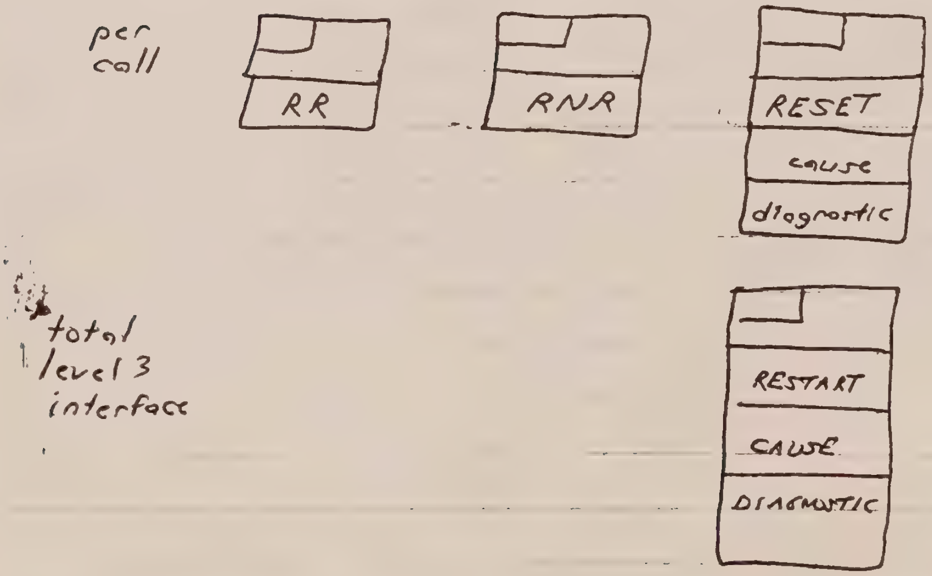
X.25

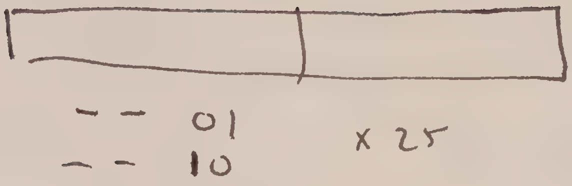
info field formats

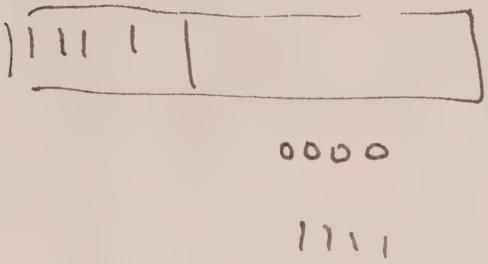


causes:
- end-point originated
- station busy
- out of order
- remote procedure error
- local " "
- incompatible destination
- invalid facility request
- network congestion
- not obtainable
- RPOA out of order

housekeeping

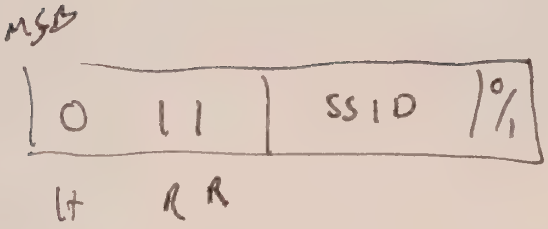






no layer 3

see next octet for PID



400 PSK
1200 PSK
1200 MSK

Level I PLR, HM, DJ4ZC, G8DQX
W3OTC W3IWI W3GEY KD2S
SM0 NBS

TO: HM
FROM: DC
SENT: 28 APR 82 09:25:11
READ: 28 APR 82 23:23:09

to: AMICON Standards Committee
from: Den Connors KD2S
c/o Tuscon Amateur Packet Radio
P.O. Box 22888
Tucson, AZ 85734
(602)-744-9306

Please take a look at this draft, and give comments to Hank or me....

Amicon Interim System Specification
for the
AMSAT Phase III Satellite Channel L1

This document is meant to be used as an adjunct to the AMICON SYSTEM SPECIFICATION. The applicability of these interim standards shall be for a period to be detrmined by the Amicon Coordinator. Any part or all of this interim standard shall be subject to revision or elimination as the system matures. Refer to the main document for additional information on each interface level.

LEVEL 1 INTERFACE: PHYSICAL INTERFACE

1.1 Channel Assignment and Characteristics

An attempt shall be made by system nodes to keep the frequency of the unmodulated carrier as close as possible to 11.25kHz above the received frequency of the general beacon, measured locally.

1.2 (not applicable)

1.3 Carrier and Modulation Specifications

Access to the Amicon channel shall be by appropriate transmitting/receiving equipment, with a design capable of providing a signal-to-noise ratio on reception by the satellite of about 20dB or better.

Audio Frequency Shift Keying (AFSK) shall be used to modulate the transmitter. Input to the modulator shall consist of a steady 1200Hz tone to indicate a mark condition, and 2200Hz for space (Bell 202 tones). Total bandwidth of the modulated RF signal shall be restricted to 15kHz, within which will be contained all signals with levels in excess of 20dB below the carrier level. [This modulation technique is compatible with all currently available amateur packet modems. A separate effort will be pursued, using the mode X transponder to experiment with advanced modulation techniques for introduction into the Amicon Standard.]

1.4 (not applicable)

1.5 Data Terminal Equipments

No attempt will be made by this document to standardize on the mechanism of interfacing the user data equipment to the system nodes.[It

is assumed that the terminal node controllers being used will be interfaced either with an RS-232-C serial port, or some custom parallel interface.]

LEVEL 2 INTERFACE: PACKET TRANSMISSION SPECIFICATIONS

2.1 Packet Framing Specifications

No attempt will be made by this document to standardize on the mechanisms required for station nodes in attached local area networks to access the Amicon access nodes; rather, only the Amicon node (gateway) protocol will be specified, as described below.

High-level Data Link Control protocol (HDLC) will be used to control the multiple access channel.

2.2 Transmission Code

No attempt will be made by this document to specify the type of transmission code to be used within the packet.[The lack of standard specifically allows both ASCII transmission and binary file transfers; the latter will be very useful during experimental phases, for transferring program files containing the latest Amicon network updates.]

2.3 Channel Multiple Access Protocol

Access to the channel shall be by non-carrier-sensed multiple access (ALOHA) and carrier-sensed multiple access.[The latter standard allows use of sensing satellite transponder output during transmission of blocks of (identified) multiple packets, which will have transmission times greatly in excess of round-trip travel times.]

2.4 Addressing Scheme

Each Amicon node will be assigned a single-byte unique binary identifier. Addresses will be obtained from the Amicon Coordinator at some time before a gateway comes on-line.[There are several current and planned addressing schemes for local area networks. However, the very small number and immobility of the interim network nodes allows this extremely simple and efficient mode of addressing.]

LEVEL 3 INTERFACE: NETWORK SPECIFICATIONS

3.1 - 3.4 (not applicable)

No attempt shall be made by this document to standardize the mechanisms for controlling the higher network functions of the Amicon network.[There are several schemes to attempt during the experimental period: the network level (3A) protocol may be performed with datagram or virtual circuit techniques, and the internetwork protocol (3B) has parameters which should be investigated before standardizing. For the latter protocol, the NBS Internet Protocol has been preferred by all active groups, and AMRAD has devised a good addresing scheme to fit within the standard's boundaries.]

LEVEL 4 INTERFACE: TRANSPORT LEVEL PROTOCOL

No attempt shall be made by this standard to specify any higher-level network layers of the Amicon network.[The NBS is currently working on higher-level protocols for networks, and has five Transmission Control

Protocol (TCP) standards, of which the #2 protocol is probably most appropriate. The Bureau is aware of our current activities, and will be sending complete documentation and coding (listings and machine-readable code written in C and PASCAL) to assist in AMSAT's Amicon experiment. Copies of Internet Protocol (IP), TCP, and session control protocols are being delivered.]

73, Den

TO: HM
FROM: PLR
SENT: 21 APR 82 05:18:25
READ: 21 APR 82 06:22:03

Dear Hank,

In re: AMICON Interim Standard

This represents AMRAD's thinking toward the AMICON interim standard that you are now drafting. It also gives you our thoughts on local area and backbone networking issues.

Communications Channel

We have no problems with the ideas expressed on the telecon. Virtually everyone who is active on packet radio today is using the VADCG TNC, Bell 202 modems to afsk a vhf-fm transceiver with 5-kHz deviation and about 15-kHz rf bandwidth. Unless we stick with these parameters for the communications channel, the packet people will be hard-pressed to reconfigure by the time that Oscar Phase III-B is launched. It is a bit wasteful of bandwidth (as opposed to fsk), but that is a trade-off to allow people to use their present equipment.

Physical Level

There do not appear to be any issues at this level. Everyone in North America is using RS-232-C, and others may use X.21.

Link Level

The link level protocol, in our view, is essentially noncontroversial, at least to the extent that there appears to be a consensus for using HDLC. The main issue here is addressing. There may be some issues concerning the control field, but these are secondary and can be deferred for now.

Dynamic vs. Static Link-Level Addressing

We are fundamentally opposed to dynamic addressing at the link level. One of the strongest reasons is that each individual amateur packet radio station should be able to come on the air at link level and use his TNC board to connect without having to check into a particular network controller to find out his address. He already has one (his call sign), and we see no reason to avoid using it for link-level addressing. This permits an anarchistic mode of communications, and permits operation whether or not there is a network controller present. The ability to communicate after loss of a network controller is vital to emergency communications. It may be key to our being able to stay on the air after a nuclear attack. (Right now, that's against the law. The case is being made now to the DoD that Amateur Radio can survive and that the law should be changed to permit post-attack operation. If the packet net is designed to survive, we have some chance of getting some DoD funding. In our view, the prospects of DoD funding are not at all certain and should not be the driving force.)

The details of our argument for static call sign link-level

addressing and against dynamic addressing are spelled out in Terry Fox's article, "Level 2 Protocol Proposal," which appeared in the AMRAD Newsletter for March 1982. This article had only terrestrial packet networking in mind. There are even stronger arguments for static link-level addressing for satellite and hf links. The satellite's moving footprint complicates both addressing (if done dynamically) and handoff from one net-control station to another (there dynamic addressing would be just one more part of the complexity). At hf, the propagation medium is changing so rapidly as to seriously question the feasibility of net controlling at all (it would be further aggravated by dynamic addressing). These problems are eliminated by static call sign addressing at the link level.

The call sign approach will allow a user to move around several networks freely without having to worry about addresses each time. Even if he moves from a local 2-meter network to an hf link with a buddy three thousand miles away, the address won't change.

There are two important things that should be added to the March article. One is how the "request-to-repeat" and "repeated" bits fit in. The other is that we are no longer thinking only in terms of having only the call sign of the transmitting station in the HDLC address field -- it changes according to circumstances, talked about below.

In this address scheme, the letters of the amateur call in the address field are forced into upper case, which uses 6 bits per character. If we assign the request-to-repeat bit to the first octet of the address, and the has been repeated bit to the second octet, there is more than enough room. This would also allow us up to 5 other bits (one spare bit per octet) for future expansion.

While at first, we were considering using only the call sign of the sending station (not necessarily the source, as in the case of relaying). We heard arguments which said that we should use the call sign of the intended receiving station. That argument ran like this: If you are transmitting on a frequency which has repeaters to the West, North and East, all repeaters may repeat the packet if the sending station's call is sent. This could be eliminated by substituting the call sign of the intended receiving station (repeater in this case). Terry has been working on a more complex scheme which sometimes uses the call of the sender and the receiver, according to whether balanced or unbalanced modes are being used. More on this in the near future.

In the opinion of most network designers, the link level is not the place for other functions, such as device selection within each user, multi-user hookups, or how to route the data thru the system. It has enough to do just maintaining the data link reliably between two points. The above functions are for the higher layers. Therefore, we recommend that we use a version of HDLC called ADCCP. This is very similar to what we are using on the air in most of the country with the VADCG TNC board.

Hf is probably a special case. We would like to use HDLC to the extent possible. But, link reliability would be poor. We need a combination of ARQ and FEC (forward error control)

protocol. We envisage a special board (similar to the TNC) for hf packet links. This subject will be developed later. Clues to our thinking are in the hf standards section of Paul Rinaldo's paper in Volume 1 of the proceedings of the ARRL Amateur Radio Computer Networking Conference, October 1981 and in AMRAD VuGraphs 82-31, "Proposed Packet HF Channels," and 82-32, "Rx for HF Packets."

Network Level

The network layer has often been divided into two sublayers, called the "network" sublayer, and the "internet" sublayer. The first is responsible for maintaining control over a group of links, while the internet layer is used to send data back and forth between these individual networks.

Network Sublayer

The network sublayer (called by NBS layer 3A) is responsible for maintaining the individual link connections from the link layer, and it is also responsible for routing the data from the sender to the proper receiver(s). Since there can be several link level connections going on at once, there is the potential of overloading the network with data. A system similar to level 2's flow control is used at the network level to make sure the network doesn't get overloaded.

The network layer is also where group connections can be made.

After a lot of research, and talking to several people in the networking field, we recommend that the amateur packet community use the X.25 virtual circuit standard at the netork sublayer of layer 3. Usually the individual networks will be reliable enough to support a virtual circuit system, such as X.25. We do not envisage use of the datagram provision of X.25; no one else is using it either. (X.75 would apply to the AMICON. For hf, we feel it unlikely that a network sublayer protocol is either needed or practical. This will be left to separate study.)

Again, we recommend static addresses. The X.25 format calls for 14 quartets (semi-octets), BCD encoded with A-F not used in the current version of X.25. That forces us to encode call signs in their decimal equivalents; i.e., 2 decimal digits per letter in the call sign. (This is something that could change in X.25, opening up a future possibility of something a bit more elegant here.)

Internet Sublayer

The internet sublayer (called layer 3B) is used to connect the individual networks together so data from an individual on one network can be sent to someone else on a different network. This layer is NOT used instead of the network layer, but rather in addition to the network layer. It creates its own headers, and has separate information from the network sublayer.

We recommend use of the NBS Internet Protocol. We do this while realizing that the NBS IP is subject to change on its way to become an ISO standard.

Again, we recommend that static call sign addressing be used at the Internet level. Unfortunately, the format has to be different from those used at the link and network levels.

The call sign is good in one respect - it's unique. It's poor in another - it doesn't designate the location. So, just the call sign would identify the entity but not where it can be found. A look-up table would be theoretically possible, but it's not practical to have every network node keep a table of every ham in the world, where he is, and how to route to him. In fact, most everything in print says that imbedding the routing in the address is a mistake - it ties that location to a given routing unless alternative routing schemes are devised.

So, a good address would include two elements:

(1) who (unique to the host ham station), and

(2) where (unique designation to the area).

That's crowding things to get both of these things into the NBS Internet address field, but it can be done.

The NBS Internet address field consists of 64 bits overall. These 64 bits are subdivided as follows:

The first 16 bits comprise the Digital Network Identification Code (DNIC), further broken down as follows:

4 bits: Zone (continent or ocean)

8 bits: Country (each country has one or more country numbers - the U.S. has 3 now)

4 bits: Network (assigned by the country authority - the FCC in the U.S.)

These 16 bits are organized into BCD quartets, corresponding to the digits 0-9; A-F are not used. The rules for the above DNIC scheme are governed by CCITT X.121.

The remaining 48 bits are terminal addresses and are to be assigned by the specific network.

Assuming that we want to be compatible with the NBS Internet Protocol and its address structure, we could go to the FCC and ask for the assignment of a DNIC for the worldwide Amateur Radio packet network. That would be one international DNIC for hams. The alternative would be to have each Radio Relay League go to their respective telecommunications authorities and get one for each country's Amateur Radio service. That alternative doesn't make a lot of sense in that it can be expected that some countries will assign a DNIC, but most will not.

In any event, the DNIC is assigned by higher authority. We (as a network) need only concern ourselves with how to allocate the last 48 bits.

The call sign, as a unique identifier for a host ham station, would be worth considering as something to put in the

48-bit address field. If one organizes it into octets, it would take 6 octets for the call sign. That would take up all 48 bits just for the call sign. This is not acceptable because we also need to encode location as well as call sign.

Is it the thing to do to extent the 48 bits to whatever is needed for the call sign and whatever else is required? We don't think so, because we've violated the NBS Internet Protocol and done so without much justification. Also, that would contribute to additional overhead which is universally frowned upon.

Can the call sign be made to fit? Yes, thanks to the organization of the ASCII code. Amateur Radio call signs consist of up to 7 characters. The first two characters can be either figures or letters. The third character is always a figure. The suffix of one, two or three characters is always literal. For shorter call signs, the spaces not occupied by a letter or figure are nulled. By knowing in advance the most-significant bits of the ASCII characters used in the call sign, we don't need to transmit them. That permits the following number of bits to be used:

Example call sign:	W	D	4	I	W	G		
Bits required :	6	6	4	5	5	5	=	31

This leaves us (48 - 13 =) 17 bits to play with.

These 17 bits are sufficient to accommodate a 1 degree by 1 degree grid system over the entire earth. 8 bits are needed for north and south latitudes (8 bits provide 256 possibilities, while only 180 are needed). 9 bits are needed for east and west longitudes (9 bits provide 512 possibilities, while only 360 are needed). Stations would use the integer degrees of longitude and latitude, not round off. Those stations above (say) 32 degrees latitude would use only even longitudes. This would make us compatible with the European QTH system, and it would be possible to translate back and forth.

There is much more to talk about. We don't have the time to write more until after Dayton. We haven't discussed the Transport level, which is the level that generates/breaks down the datagrams at the Internet level.

Dave Borden is out of the country for a few weeks, but we went over this prior to his departure. We also had an opportunity, at the Trenton Computer Festival last weekend, to discuss much of this with Steve Robinson but mainly in the context of the East Coast terrestrial network. We think that Steve's thinking and ours are very close and that we can resolve the remaining differences and misgivings at our next meeting with him.

73,

Terry Fox, WB4JFI   Paul Rinaldo, W4RI

TO: HM
FROM: DC
SENT: 21 APR 82 07:46:39
READ: 21 APR 82 16:37:47

To: Hank
From: Den
Re: AMICON interim standard

Here are suggestions for the interim standard:

1) physical protocol

a) medium- Let's use our 15KHz unwisely for the time being, and keep an AFSK standard until better modems can be produced. We are committed to building the AMSAT 23cm linear amplifier, and should use the available 600KHz digital channel up there for low- and high- speed experiments. We are contacting other Universities who are experimenting with coding and modulation schemes, looking for the best, easiest system.

b) connection- RS-232-C is standard; also, let personal computer owners use their TNC's through whatever (parallel) scheme their TNC allows-- it matters not to the AMICON net.

2) Link Level-

a) Present and future VADCG and TAPR boards will be using HDLC; let's stick with it.

b) addressing- The present TAPR board and future VADCG boards will be using dynamic addressing, which presents no fundamental problems. The "net control" or "station node" is a very simple function which may be handled by the linking TNC. The amateur call sign is wasteful of byte-space in systems with fast turn-around times, while a single byte is all that is required for unique addressing at the local area net level. Checking into the net controller is identical to checking into the link, since they can be the same device (not required, but easy to implement). The loss of the network controller is then the loss of the link, and vice-versa, so that there is only one central point of failure, identical to the case of having no net control. The place for the amateur call sign is at the network level, so there will be no need for the transmitting station to know the binary address of the receiving station-- no bulky, global routing tables are required.

It is unfortunate that the original VADCG boards used the temporary expediency of assigning unique addresses to each board while the group was waiting for the station to station protocol to be completed. This has led to a de facto standard which will require changing all PROMS out in the field when VADCG completes their protocol. The concept of multiple ID's, common in most commercially available LAN's, has momentarily been lost to amateur radio, and with that loss goes several simple sub-net and server access schemes.

In the opinion of most of the network TNC hardware designers, the link level is not the place for a long amateur radio call, or complicated control and routing mechanisms. This level should just handle data linking in as efficient a way as possible. We believe the dynamically alterable net control station, giving out dynamic addresses, to be the most robust mechanism for surviving network node failures, allowing easy routing through multiple, unique binary ID's existing concurrently. Although the link station always may become the NCS, reliability is only guaranteed with multiply available links, a point to remember when allowing only one AMICON link per city.

3) network level

a) network sublayer- X.25 is an acceptable standard, but experimentation at this level will not impact operation of AMICON. Both VADCG and TAPR are going to experiment at this level.

b) internet level- NBS internet protocol would probably be the most likely candidate for mutual mapping of dissimilar network sublayer protocols. For the interim standard (determining how to make our TNC's talk on the channel) however, I would suggest using naked network sublayer. The TAPR TNC will be able to talk VADCG protocol without modification, and VADCG boards appearing in a TAPR net cause the NCS to go into VADCG digipeater mode automatically. The only problem is to use the least common denominator for digipeater protocol... the VADCG system will probably have smarter digipeaters at all LAN sites at about the same time that We're ready to switch over to the full I.P. on AMICON, so I don't think we have to worry about trying to make the various nets talk the same network sublayer protocol in the future.

I suggest we incorporate I.P. as soon as the main LAN sites are ready, and certainly within one year of launch. Pauls suggetions on addressing schemes are very good, and fit within the I.P. standard. I will continue to discuss I.P. with Bob Blanc at NBS, and with the fellows at SRI who are trying to make the required software fit microprocessors.

Please note that Paul and I basically disagree only on the need for dynamic versus static addressing at the data link level, and that this does not impact the AMICON operation in any way, since the hardware systems currently out are mutually compatible, until dissimilar schemes are created. This is an important experiment, which I look forward to, as a member of AMRAD.

It might be best for AMICON to continue the policy of allowing LAN's to use whatever techniques best fit the experimenters' desires, and standardize at the levels of impact only-- the physical and network layers.

73, Den KD2S

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73, Den KD2S

AMICON
AMSAT INTERNATIONAL COMPUTER NETWORK

The following are notes from an hour and a half long conference call commencing at 03:00 UTC 27 March, 1982 regarding AMICON system planning for the AMSAT Phase IIIB satellite. Among the participants were:

*	WA2LOO	Vern Riportella	NY (Moderator)
*	KA6M	Hank Magnuski	CA
*	KD2S	Dan Connors	AZ
*	W2FPY	Steve Robinson	NY
*	W4RI	Paul Rinaldo	VA
*	W4OWA	Bob Rueidisuli	VA
*	K1HTV	Rich Zwirko	MD(DC)

After introductions and a statement from chairman Riportella of the objectives of the conference call the following items were presented to or discussed by the group:

* K1HTV Described the revised Phase IIIB SSC (Special Service Channel) concept. This involved reducing the number of SSCs from six (as originally planned for Phase IIIA) to four SSCs, namely (L1,L2,H2 & H1). Details of the changes in the form of two articles co-authored by W4OWA and K1HTV to be sent to all participants in this call by W4OWA.

* AMICON standards for use of SSC L1. (Please note the change from the original L2 SSC to L1.) After discussing the pros and cons of a number of modulation techniques it was decided that the best way to start was to select the mode which would give the greatest number of AMICON users the opportunity to participate in early days of Phase IIIB. The mode recommended was AFSK-FM. Since the Bell 202 type hardware seems to be one of the most popular and easily obtainable units it was agreed that the 1200/2200Hz tone combination be used. W2FPY pointed out that the Bell 202 standards are compatible with the foreign V.23 standards thus allowing non-U.S. Amateur participation by those with access to this type of equipment. W4RI estimated that even with 2 or 3 KHz deviation, the bandwidth required for AMICON based on the tones to be used along with the 1200 baud rate would be approximately 15KHz. 2200 X 3(third harmonic) plus 1200(baud rate)= (+/-)7800Hz bandwidth.

* It was agreed that AMICON should be allowed to be in an experimental mode for a number of months after it is first put into operation on Phase IIIB SSC L1.

* Discussion followed on limiting AMICON users to potential gateway stations and that some kind of certification or qualification procedure be established to check the competency of users before they transmit packets on AMICON. This would be done in order to reduce the amount of possible disruptions by stations not quite ready.

KA6M

DEAR Hank,

The enclosed is a draft copy of the second of two articles about the proposed Phase IIIB Special Service Channels. The first article appeared in ORBIT magazine #10 and this one is tentatively scheduled for ORBIT #12. Please send any comments as soon as possible as I am told the deadline is fast approaching. Thanks.

73, Rich

Richard Zwirko K1HTV

W2GFF

Richard J. Peacock
9 Andrea Drive
Setauket, N.Y. 11733

Office: 516-595-4897 Home: 516-941-4943

January 19, 1982

Hank Magnuski KA6M
311 Stanford Avenue
Menlo Oark, Cal. 94025

Dear Hank,

In view of your present satellite activities, I am sending you an advance copy of a manuscript that has been submitted for publication by AMSAT. I hope you will be able to help in the preparation of an Operations Manual for users of the forthcoming Phase III-B satellite.

After you have examined the outline, and the more-detailed checklists, I believe you will find there are specific subject areas in which you have personal interest and expertise. Your assistance in preparation of the manual will be most appreciated, and I earnestly hope you will be able to indicate the areas and extent to which you can participate.

I am looking forward to your reply.

73, Dick

Encl: Rev A, 12-10-81 13 pp

The general format of the Operations Manual will be as follows:

GENERAL

- Purpose
- Scope
- Policy
- Definitions and Terminology

TECHNICAL CONSIDERATIONS AND CONSTRAINTS

- Satellite Systems and Capabilities
- Orbital Parameters
- Propagation and Link Calculations
- Operational Lifetime of the Satellite
- Ground Station Considerations

OPERATIONAL CONSIDERATIONS AND CONSTRAINTS

- AMSAT Operations Organization
- Transponder Band-Plan
- Satellite Tracking
- Monitoring Satellite Performance

DETAILED OPERATING STANDARDS

- General Beacon
- Engineering Beacon
- General Operation
- Special Services Channels
- AMSAT Coordination and Network Frequency
- AMSAT Standard Operating Practices

APPENDIX

- Computer Programs
- Schematics for Ground Stations
- AMSAT Directory

The outline below describes the present concept of the format and subjects to be included in the manual. The manual will address only the AMSAT Phase III-B satellite. Since all operations through the satellite are basically governed by the technical features of the on-board systems, and by the orbital parameters actually attained, these subjects are addressed in considerable

detail, along with their impact on ground station design. Operational considerations and constraints are then discussed, and a practical operating philosophy is presented that is based on the technical constraints of the equipment and the orbit. The final section of the manual will consist of detailed operating standards, in which will be provided recommendations on how to implement practical operation by users in the most effective manner. These detailed operating standards will summarize the technical and operational factors that must be coordinated among users for effective utilization and communication. This section of the manual is intended to be flexible, so that it may be updated to reflect current operational experience with the satellite.

Although this document is to be titled as an Operations Manual, it may turn out to be a practical handbook if it is comprehensive in covering the technical details and design areas. The format has been designed so that the document may be used for easy reference in both areas.

As you scan through the detailed outline below, you will undoubtedly find specific subjects that are of particular interest to you. You will, of course, identify many of the subjects and sections with some particular call or name. Obviously, much of the material covered in the outline has already been published in ORBIT or some other publication in one form or another. Many technical details, however, are still being refined by those people actively constructing the Phase III-B satellite.

Our first task is to identify and collect the basic material already available in the various areas to be addressed. We need people to help with this activity, and it seems logical that someone with a particular area of interest will have a pretty good handle on where the best background material is located. If you have already written an article on some of the subjects yourself, so much the better. Maybe it would be a relatively simple matter to arrange it in the format presented here. Please let us know.

A few words are in order here regarding the way in which the subjects have been assigned paragraph numbers, and detailed subjects have been suggested under each major heading. The basic subjects are those which should cover all the required manual topics, although we won't shut the door on any legitimate item that may have been overlooked. The numbering system has been assigned for indexing the manual, and for a standardized reference to coordinate submitted material, and to identify contributors with specific subject areas. The detailed subjects suggested for coverage under each numbered heading are considerably flexible, but will be used as a guide to prevent duplication of coverage by different contributors. It is quite probable that a number of additional subjects will have to be added under many headings.

Many of the people directly concerned with the different technical areas, and who have the most current and accurate information on the details of the

OUTLINE

OPERATIONS MANUAL

AMSAT PHASE III-B SATELLITE

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    Beamwidth & pattern
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Block diagram
On-board capabilities
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Interfaces)

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Monitoring & verification of status)

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(Function
Description-Materials, weight, thrust
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Performance
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(Site
Date
Time
Launch Vehicle)

2.2.2 Initial Orbit
(Identify start of Orbit #1)
(Inclination
Apogee
Perigee
Argument of Perigee
Eccentricity
Period
Precession)

2.2.3 Orbital Maneuvers
(Firing of kick-motor/Injection in final orbit
Date
Time
Orbit Number)

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(Identify start of first final orbit
Inclination
Apogee
Perigee
Argument of Perigee
Eccentricity
Period
Longitudinal Increment)

CHECKLIST

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  - 3.2.3.6 Traffic Channel
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- 3.2.5 Bandplan Schematic

*Requires international agreement

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(Initial inputs from official tracking stations and other non-AMSAT sources)

(AMSAT processing of above data for AMSAT tracking)

3.3.1.2 RF Signal Measurements

(Doppler techniques, ranging techniques usable by specially-equipped amateurs, techniques usable by means of simple equipment)

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(Direct transmission by satellite)

3.3.3 Tracking Methods for Users

(Mechanical Plotters, types, designs, construction details, sources of commercially available plotters)

(Computer-aided tracking, principles, software design, programs available, direct control of antenna azimuth and elevation)

4.0 DETAILED OPERATING STANDARDS

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(Uplink frequencies

Downlink frequencies

Bandplan Considerations

Transmission Modes

Effective Radiated Power

Antenna Polarization

Receiving Antenna Gain

Receiver Sensitivity

Propagation Anomalies

Path-loss Considerations

Effects of level of user activity

Operating conventions and practices)

4.0 DETAILED OPERATING STANDARDS

4.4 SPECIAL SERVICES CHANNELS

(Identification-Channel Number and Common Name

Channel Frequency Definition

Intended Channel Function and/or Use

Channel Coordination

- User's point of contact at AMSAT, and locally, if any
- Information Dissemination
- General Policies
- Scheduling
- Channel availability and sharing

Technical Standards and Requirements

(Describe applicable characteristics as necessary to provide proper interfacing between all users.)

- Transmitter characteristics
- Receiver characteristics
- Modulation characteristics
- Transmission rates
- Decoding requirements
- Data formats, conventions and protocols
- Precautions and constraints to prevent inadvertent damage or degradation of satellite

Operational Standards and Requirements

- Operating Conventions and Practices
- Minimizing interference between users
- Licensing Responsibility

1263 Balfour Avenue
Vancouver, B.C.
V6H 1X6

H.S. Magnuski, KA6M
311 Stanford Avenue
Menlo Park, CA 94025

Dear Hank,

I have forwarded your donation to our secretary. Thanks very much.

You asked for comments on the AMICON system specifications. I have read your draft revision 1.01 over and jotted down some comments and impressions.

In general, you have done an excellent job in getting down to the detail level of the proposed system. Obviously, a lot of time and effort went into it. The overall system seems viable and I hope we get the opportunity to function through a future amateur satellite.

As you know from our eyeball conversation I heartily approve of your choice of the HDLC frame for your link control. I also like the closed loop control feature you have put in your protocol.

In reference to your item 1.3. It is unfortunate that as yet there are no modulation standards. I have consulted your refererence material in the IEEE Transactions on Communication and found it very useful but have come to no conclusions as to what may be the best technique. I would expect that FSK with non-coherent detection will probably be the first method attempted. It seems to me that the major additional problem created by the use of a non-geosynchronous satellite is Doppler shift. This probably means that some kind of AFC must be used in the receiver or alternatively, that the receiver bandwidth is wider than that necessary to receive the signal with best SNR. Some of the modulation methods suggested may be difficult to control with AFC.

Re 2.3.3.2 - I use the same retransmission protocol and calculation method in the VADCG system. We also use CSMA and eventually intend to provide a closed loop control system when channel congestion becomes a problem.

Carrier sense techniques will not be very effective when the sensed information is out of date by a quantity of time which is large compared to the packet length. This is the situation you have with a satellite link. In fact, under some circumstances, carrier sense may degrade through-put. As you say in 2.3.4.3, it is a subject for further investigation.

Each of the basic protocols (i.e. virtual circuit and datagram) have their advantages and disadvantages. You have chosen the datagram approach. One advantage of datagram service is that the burden of design of most of the difficult network protocol is passed into the hands of the users. The corresponding disadvantage is that the protocol

is not completely specified. There is no protocol defined which will ensure data integrity (i.e. acknowledgments, retransmissions, sequence checking). Maybe you should have gone further and made provisions for data integrity in your draft specifications and then again - maybe not. I am undecided. Data integrity is something that amateur communications have never had and amateur digital communication is the first thing to come along that could provide it.

Since you are designing the protocol for a fully connected network, you do not need any routing, only addressing (naming in this case). If you consider integrating this network in a larger network where the satellite links provide the necessary communication that the terrestrial links do not have, then this protocol would be very inadequate. I guess I am just rephrasing the statement I made in the last paragraph. Most of the protocol has to added on to this basic start.

The philosophy of this draft protocol seems to be to design a protocol which most closely approximates the protocol used by hams on the HF bands. The call group syntax is specified in great detail and should satisfy all possible combinations. At the same time, it may be a bit wordy and may increase the overhead substantially. In the VADCG system, we are converting the names to addresses and back again when necessary. This can cut down on the overhead but would be difficult to do in a datagram system. We are using the virtual circuit approach since our network is not a fully-connected one.

I note you are not using the HDLC address and control fields. I guess you intend them to be used by those who design the rest of the protocol.

It´s my opinion that the amateur satellite channels will only be carrying a small percentage of the digital traffic, at least for the next few years. Most of the traffic will be on VHF or UHF with another small percentage on HF. What we need is a geostationary satellite with a microwave transponder channel giving us the bandwidth we need. The technology is there because it is being done commercially all the time.

In summary, I think you did a good job and I would have liked to see this protocol being used with the satellite. Unfortunately, the necessary satellite probably won´t be around for a while yet. I feel that perhaps too much effort was spent in providing the same features hams have already and not enough effort in providing features they never have had before - like data integrity. This is not a serious deficiency because the users can add this to the protocol later.

By the way, the beacon is operating fairly regularly now. Have you heard it on 14.076 kHz?

73,

Doug

Doug Lockhart, VE7APU

This is the intro to Packets in my book manuscript.

I'd like to use the proposed AMICON packet format as an example (aknowledging sources of course) and give it wide publicity – then it may get adopted — or ideas within it etc.

Joe G3ZCZ

high speed burst
n only be
t at the rate
work can pass
tional mechanical
wpm is only
the actual

typing speed in a contact varies as a function of the digital dexterity of the operator, the data throughput is slow. Computers can be used to speed up the flow of information and improve the channel occupancy.

Supposing the data being typed is buffered by the computer. The contents of the buffer can then be output at high speed (say 1200 - 9600 Bauds) as a burst. If the computer checks that the channel is unoccupied before transmitting, there will be a minimal amount of loss of data due to interference (two stations transmitting simultaneous bursts are the only practical cause of such interference). If each packet or burst was prefixed by the call sign of the destination station, it would be uniquely identified. The computer at the receiving station would ignore all bursts addressed to other stations. Thus many QSO's could take place timesharing the channel. An example of such a scheme is shown in Figure -1. Any station could display all information relayed or just the messages

Packets

A packet of data can be considered as a high speed burst of information. The typical RTTY frequency can only be occupied by one QSO at a time, and data is sent at the rate that it is typed. Thus, although a Baudot network can pass data at 60 words per minute (wpm) using conventional mechanical teletypewriters, a real data throughput of 60 wpm is only achieved when running at machine speed. Since the actual typing speed in a contact varies as a function of the digital dexterity of the operator, the data throughput is slow. Computers can be used to speed up the flow of information and improve the channel occupancy.

Supposing the data being typed is buffered by the computer. The contents of the buffer can then be output at high speed (say 1200 - 9600 Bauds) as a burst. If the computer checks that the channel is unoccupied before transmitting, there will be a minimal amount of loss of data due to interference (two stations transmitting simultaneous bursts are the only practical cause of such interference). If each packet or burst was prefixed by the call sign of the destination station, it would be uniquely identified. The computer at the receiving station would ignore all bursts addressed to other stations. Thus many QSO's could take place timesharing the channel. An example of such a scheme is shown in Figure -1. Any station could display all information relayed or just the messages

addressed to itself. Thus the addition of a minimal amount of software would improve the use of the basic RTTY repeater network.

Once computers are used for high speed data burst communication links, advantage may be taken of the capabilities of the computer to provide error checking and correction capacity. Thus protocols can be defined and adopted with those ends in mind.

The main problem here is that new stations joining the network can "bomb" it if their equipment (hardware or software) is not working correctly. If an average of one new station per week joins the network and bombs it for two evenings each time, the network will suffer a lot of down time.

Several techniques can be used to minimize this problem. The station software can be tested out on a simplex or different channel, or a cheap special purpose microprocessor based circuit card could be developed that would act as a front end processor fitting between the computer and terminal unit. It would contain the buffers and network communication algorithm. Anyone wishing to access the network would be required to obtain the unit in a similar manner to the way that a tone burst or sub audible tone is required for access to a large number of two meter (audio) fm repeaters. The front end processor card could be mass produced at low cost once protocols are established. If designed properly, the protocols could be PROM based, and the same unit could be used for a number of different protocols

by plugging in a different PROM for each protocol in the likely event that different protocols be established in different networks.

The actual protocol provides a means for ensuring error free transmission of a message and is transparent as far as the message itself is concerned.

The analogy in conventional amateur radio is that the sounds emerging from a loudspeaker at the receiving station are the same as those entering the microphone at the transmitting station. In an interference free situation it does not matter to those sounds if the modulation technique was am, fm, ssb or dsb.